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The Application of Micro-Credentialing Mapping to University Degrees: a Skills Framework

UNIVERSITY OF HUDDERSFIELD

THE APPLICATION OF MICRO-CREDENTIALING MAPPING TO UNIVERSITY DEGREES: A SKILLS FRAMEWORK

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Copyright Statement

Abstract

With more students attending university in an increasingly globalised world which focuses upon qualifications and accreditations, higher education is going through a sustained period of extreme pressure and increasing expectations. With many differing qualifications becoming more commonplace, it is now becoming difficult for students and employers to adequately assess the skill gained through a course of study. Subsequently, the trust placed in these courses for developing the right skills has started to diminish.

This thesis demonstrates the potential of a micro-credentialing approach to display the skills gained throughout a course of study. It can help all stakeholders develop a more in-depth understanding of the course. Using a well-informed methodology, together with other existing frameworks, an accurate mapping solution from learning outcomes given in a module specification has been produced.

The mapping solution generates reasonably accurate skill profiles which provide further insight into particular courses of study. This approach opens up many further avenues of potential research both in terms of refining this methodology and developing an adequate cross-disciplinary micro-credentialing standard.

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Chapter One

Introduction

The origin of qualification structures dates back to the organised educational institutions of ancient civilizations (Chiapetta, 1953; Coulson, 1999). During these times, no clear career structure existed; formal education consisted of international citizenship. As many civilizations developed, the benefits of education became much more visible. By the eleventh century, the first higher education institutions were established, marking the start of the growth of higher education in Europe. Around this time, the term 'qualification' obtained a more defined meaning, based on capability acquisition, even though it still had an emphasis on social class structures (Engel, 1985).

As society matured, many jobs evolved and bifurcated into new professions. An excellent example of this would be that surgeons evolved from butchers. Butchers had no formal education within medicine and were referred to as Mr rather than Dr, whereas doctors had a formal education of diseases and treatments available at the time (Loudon, 2000). This displays a hierarchy between people based upon formal education within a professional field. To additionally validate an individual's knowledge within their chosen profession, royal chartership became synonymous with high-level professionals who were highly knowledgeable. Royal charterships is one of the first methods of professional accreditation (Department for Business, Innovation and Skills, 2014). This marked the start of a shift not only within education but also the need for specific qualifications and skills for a particular field.

The increased need for skilled employees resulted in an increased emphasis on credentialing, which has only ever increased towards the present day. During the 20th century, the emphasis shifted to technological development, leading to concerns about whether the demands on education could be met (Keevy & Chakroun, 2015). During the 1980s, influenced by integration and a focus on vocational training, the notion of a national qualification framework emerged within the United Kingdom with an emphasis upon a competency approach to vocational education (Jessup, 2003). Across all the countries which developed the first generations of national qualification frameworks (NQFs), they were based upon a hierarchical classification of formal learning programmes, their associated qualifications, and certificates (Coles, Keevy, Bateman, & Keating, 2014). NQFs linked quality assurance with learning outcomes, with learning outcomes used to determine the level at which the qualification is placed in respects of other educational programs (Tuck, 2007).

As formalisation of education was occurring through NQF programmes, participation in education increased significantly, with 84% of young people completing secondary education in high-income countries. Access to education was also expanding, with the number of people attending higher education rising sharply from 5% in 1960 to 35% in 2000 (Chowdry, Crawford, Dearden, Goodman, & Vignoles, 2004). With such rapid increases in the number of learners, it is no surprise that there have been concerns and challenges regarding current qualification and credentialing systems. In recent years, universities have been criticised for facilitating grade inflation (Richmond, 2018), while the supply of graduates in some fields far exceeds the demand for their skills (Coates & Morrison, 2016). The UK Government has been particularly concerned about skills mismatches within STEM subjects, commissioning two reviews (Wakeham, 2016; Shadbolt, 2016) to identify how these issues may be addressed.

The key finding of both the Wakeham and the Shadbolt reviews both show that STEM education and in particular computer science offer a great deal of value to both the student and employers. The reports also highlight that each discipline spans a comprehensive curriculum that is taught at a multitude of higher education institutions and like the industries they provide for, are not homogenous. Further to this, both reports comment on the role of accreditation of degree programmes to play an essential role in aligning the supply and demand for STEM skills. In conclusion, both reports state there is a careful balance between the role of educating individuals and the provision of the skills and knowledge needed to drive economic growth.

Specifically, the Shadbolt review, it describes the existence of a skills gap and that there are significant challenges in robustly and accurately measuring and interpreting the extent of the skills gap. The approach many researchers and institutions are taking is to apply the concepts of micro-credentialing to assess and fill the gap produced with the mismatch between higher education and employers (Crick, Davenport, Irons, Hanna, & Prickett, 2020; Oliver, 2020). Therefore, the burden of meeting the needs of all learners should be shared between higher education institutions and employers.

1.1 Research Motivation

With education being under much criticism and with credentialism being much more apparent within education, particularly for higher education, a more transparent approach to understanding a particular individual's skill set is more important than ever. While some current frameworks exist within the field of education, these are not explicitly applied to higher education programmes.

The primary motivation for this research is to develop a framework based on existing literature that can be applied to a higher education programme. This will allow for much better insight into someone's skillset while also partially resolving the ambiguity of degree programme names, which in this thesis will be Accountancy, Computing, Engineering, Language, Law, Marketing and Psychology. This being based on a two-iteration approach; the first iteration being at the national level to determine the overall skillset expected. The second iteration being at the module level to gain a more granular view of skills gained within a particular programme of study. This iteration approach should represent accurately enough the expected skill distribution gained on a particular programme of study.

1.3 Contribution

The work contained within this thesis aims to make multiple improvements and aims at adding many potential avenues of research in the future. These include:

- The viability of micro-credentialing within traditional higher education programmes of study. Showing that there are new alternative methods which can help supplement information given through a traditional transcript.
- Displaying that higher education is under many pressures which could potentially be resolved with a more transparent approach to displaying skill obtained through a programme of study.

- Outlining potential areas of further research in the emerging field of micro-credentialing and showing that this field holds much potential for further growth.

1.4 General Overview

Chapter one introduces the basis on which this thesis is presented, showing that the current qualification structure in higher education could still go through further changes. Detailing issues that have caused mounting pressures on higher education and covers all critical matters for this thesis and highlight vital points throughout the next sections.

Chapter two provides an extensive literature review into the current state of higher education and potential problems which have arisen with the rapid changes partially caused by globalisation. Chapter two moves on to discuss the previous applications of alternative accreditation, micro-credentialing and professional body frameworks which inform the work carried out within this thesis.

Chapter three outlines the methodology, beginning with the method of how to conduct the first iteration mapping for QAA statements and also professional body requirements. Chapter three goes on to describe the methodology for the second iteration mapping, which is conducted at a module level for both subject-specific skills as well as transferable skills mapping.

Chapter four goes through the application of the methodology on various programme specifications and professional body requirements and comparing the distribution of learning outcomes across multiple different skill areas and containers. It then goes on to complete the second iteration mapping for computing, comparing the distributions between the first and second iteration mapping for accuracy while also allowing for a greater insight into the estimated skill gained through a particular programme of study.

Chapter five reviews all the information obtained by following the methodology provided in chapter three. Furthermore, it assesses the effectiveness of the methodology on displaying the distribution of skills for a particular programme specification. This includes potential improvements which could be made to the methodology, concluding with remarks and recommendations for future work which could build on this thesis.

Chapter Two

Literature Review

2.1 The Impact of Globalisation on Higher Education

During the last half-century, the speed at which globalisation has been occurring has risen significantly and has allowed global GDP to rise considerably. GDP in 1970 is three trillion and rising to 87.7 trillion in 2019 (The World Bank, 2020). Some of the elements for this rapid growth have been vast improvements in transportation, freedom of international trade and developments within communication technology. These improvements have allowed more products to reach larger international markets, and therefore increasing industrialization allowing an increase in exports and imports between nations. Given that most international trade takes place between developed nations (World Trade Organization, 2019), globalisation has been increasing dramatically in several developing countries, this can be observed through their increasing combined exports and imports with these figures increasing by an order of magnitude since 1960, with largest sustained year on year growth being within the last 25 years (Robertson, Brown, Pierre, & Sanchez-Puerta, 2009).

Globalisation has had a tremendous and visible impact on physical goods and services in all parts of modern life. A less thought-about aspect of globalisationis its effect upon education, and in particular, uponhigher education. Higher education institutions differ across the world as many are ingrained with values of their foundational predecessors which have been recreated within their core aspects up until recent years (Massimiliano, 2004). This has created a very different and not entirely comparable educational system across the globe. For institutions, this has not been an issue until the last half-century, in which time, there has been a rapid increase of mass transport across the globe, together with increases in workforce and student migration. Globalisation is forcing many higher educational institutions to change their embedded policies and outdated value frameworks (Massimiliano, 2004).

In terms of educating the workforce, all nations have seen an increase in the number of school leavers entering higher education. The rate of admission has gone from roughly 15% to almost 50% in some countries (Trow, 1973; Roser & Ortiz-Ospina, 2021). The UK had gone from 19.3%

participation in 1990 to almost 50% in 2017 (Department for Education, 2019; Bolton, Education: Historical statistics, 2012). This has many causes and effects which shall be discussed here.

As trade has increased across the globe, the nature of the employment market has changed, particularly with the rise of automation and online marketplaces. This has then reduced the overall demand for workers for repetitive tasks (The World Bank, 2019). The decline in industrial employment in some developed countries has coincided with a shift to a more service-based economy, forcing many workers to develop new knowledge-based skills. This dramatic shift has increased the demand for higher education, where the future workforce can learn more advanced skills to increase their employability and income (OECD, 2020). Increasing automation has allowed for a better educated populous as well as a broad demographical shift within various jobs, this has a big impact upon the whole education sector. Given that such a change is not limited to education, the effect of globalisation has had results in almost every long-established institution. For the most part, such changes have been positive, but they can still hold concern for some. Increases in foreign investments across the world have created an opportunity for rising wages and more employment opportunities, but at the same time is forcing changes upon the structure of the economy.

The knock-on effect upon higher education is that it is increasingly being expected to deliver higher employability, income, and skills (Department for Education, 2018). Higher education has started to change from a social institution to a more economical one where education becomes a commodity, a product to be purchased, or more precisely a set of skills to be acquired through the transfer of knowledge (Molesworth, Scullion, & Nixon, 2011). Another report suggests that its increasing international trade is to also include postsecondary education and further states that there is a risk that knowledge will gradually become a commodity, with the production and dissemination to become an increasingly marketable commodity (Damme, 2002).

Higher education is, therefore, becoming increasingly accountable for its products and their quality, and it is becoming increasingly important to be able to demonstrate and deliver higher employability, graduate incomes, and skills (Ryan, 2015). This can be seen with the founding of The Quality Assurance Agency for Higher Education (QAA) in 1997 in the UK

(Quality Assurance Agency, 2019). Other nations have founded similar agencies such as The Commission of Academic Accreditation (CAA) in the United Arab Emirates (Comission of Academic Accreditation, 2021) and The China Academic Degrees and Graduate Education Development Centre (CDGDC) in China (China Qualification Verification, 2021). The mission for all these different organisations is the same, they are to ensure the education provided by institutions under their jurisdiction are providing high-quality education.

2.2 The Changing English Higher Education Landscape

Universities are having to adapt to rapidly changing conditions within the global market, as currently it is known to be the most significant time for an economic, social, and technological change with new fields such as Information Technology & Services, Computer Software and Financial Services being the fields with the most significant growth in 2019 (LinkedIn, 2020). The demands of retraining the existing workforce while ensuring that new graduates are well equipped for the workplace is putting a strain on well-established institutions that have been inflexible to change. The lack of flexibility can make institutions less desirable to customers very quickly, with newer institutions filling the space they previously occupied, this is seen most prominently in retail with old retailers going bankrupt and new ones taking their place (Wright, Heijden, Bradfield, Burt, & Cairns, 2004). Universities are being found in this position with an ever-growing mismatch between skills that are being taught and the skills which employers are demanding from recent graduates (Allen & Weert, 2007). With graduates being perceived as not having the skills required by employers, employers are either facing an labour shortage or will have to train their new graduates with the skills they will need to complete their jobs (The Centre for Social Justice, 2019).

Many of the issues, which will be discussed below, can be considered troublesome and if not addressed promptly could cause significant problems for higher education around the world:

- The increasing number of students in higher education over the last 30 years, the increased financial stakes for students, and the risk of academic grade inflation.
- The increasing gap in student numbers between science and non-science subject areas are high, even though all significant emerging fields are closely related to STEM fields. This section shall explore if higher education is exacerbating the issue for the sake of rapid growth in student places, what effects this has upon employers, and their attitudes towards higher education.
- A point to briefly discuss and highlight academic league tables and the idea that these could potentially promote conflicting interests for an institution, as it is too hard to gauge if some academic institutions are playing the 'ranking game'.
- The diversity of degree programmes, and how the same-named degree at two similar institutions could be vastly different in content. Currently, the only way to differentiate between the two degrees would be an in-depth look into the transcript with supporting documentation from each institution's website.
- The transformation of higher education from a social entity to a commercial entity as education has become more of a commodity.

2.2.1 Increasing Student Numbers

As previously stated in section 2.1, student numbers have almost doubled in the last 30 years, with brief view of why that could be from a macro perspective. This section of the literature review will explore this in greater detail including potential causes, and repercussions of this.

In the last two decades in the United Kingdom, higher education has gone through rapid changes in regard to university undergraduate applicants. From 1994 to 2018 there has been an increase of 97% in acceptance into higher education and as to be expected number of degree granting institutions have also increase within this time frame (Bolton, Higher education student numbers, 2021).

	1994	2000	2010	2017	2018
APPLICANTS	405,000	442,000	697,000	700,000	696,000
ACCEPTANCES	271,000	340,000	487,000	534,000	533,000

DIFFERENCE	134,000	102,000	210,000	166,000	163,000
THE RATIO OF APPLICANTS TO ACCEPTANCES	1.49	1.3	1.43	1.31	1.31

Table 1: Table showing of all higher education students' numbers, including international students, at critical points throughout the last 30 years (Bolton, Education: Historical statistics, 2012).

Table 1 shows that in 1994 there were fifteen applicants for ten undergraduate positions and number of positions. The number of applicants can be seen to be slowly rising on a gentle gradient between 1994 and 2000. This is to be expected as higher education has started to become more accessible due to improvements in secondary educational systems, also pointing towards the fact that higher education is becoming much more accessible to everyone, therefore moving it away from its very distant past of an extremely elite system which only the wealthy or very intelligent could engage with (Hansen & Vignoles, 2005). The point of significant concern for many is the dramatic increase in student numbers between 2000 and 2010. During this period, the number of applicants has gone up 55%, and the number of acceptances has gone up 43%. This significant rise can partly be explained by vastly improving secondary education in the UK (Bolton, Education: Historical statistics, 2012), as vast improvements made through educational policies with measurable goals (McAleavy & Riggall, 2016) were made within the last 50-60 years which have enabled more students to reach a much higher academic standard. Rates of school leavers with no passes have dropped consistently between 1995 and 2009 (Bolton, Higher education student numbers, 2021). However, a main point of focus is the extreme increase in attainment at GCSE level, were students achieving 'good' grades (Good grade – meaning that the student achieved five or more GCSE qualification at a grade C or higher) increased from 30% in 1990 to over 80% in 2009 supported by an increasingly good schooling system (Department for Education, 2010).

Another point to note is that for the academic year, 2008/2009 attendance at higher education increased by its most significant amount year on year. The change could potentially be explained by which financial aid was given to students making it much more accessible than ever before to students which could not afford university fees (Student Loans Company, 2019). In conjunction with the financial crisis of 2008, it could have been a safe option to enrol into higher education to learn a useful skill while also attempt to wait out the turmoil in the job market.

An interesting thing to note is the ratio between applicants to acceptances. Over time, this value can be seen to be fluctuating and with a general trend of this ratio lowering since 1994. This drop could have unseen effects and more significant concerns to that of increasing student numbers. Between 2010 and 2017 has further information and policy changes; students achieving AAB at A-level were removed from student number control in 2012, this threshold was reduced to AAB in 2013 (Hillman, 2014); additionally, university admittance cap of 30,000 per institution was lifted in 2015 (Bolton, Higher education student numbers, 2021). The requirement of students achieving a minimum set of grades lowering, and the student number cap being lifted could be a reason for the increase in the number of places between 2010 and 2017 and within this period the number of applicants has stayed roughly the same during this time therefore there were more places per applicant. This can point towards universities accepting more borderline students which would have previously been unlikely to attend university due to their A-level grades. This can potentially have many knock-on effects about the quality of students and therefore quality of graduates, but this is outside the scope of this research project.

With these multiple changes, it means an ever-increasing number of students are finishing university, in the academic year 2018/19 the total number of qualifications achieved was 801,135, up from 777,005 in the 2017/18 academic year (HESA, 2020). Currently 42% of the UK population, in 2017[1], aged 24-64 have achieved a higher education qualification compared to only 24% in 2002[2]. This is set to increase even more in the coming years (Department for Education, 2019; Clegg, 2017). As the number of degree-holding individuals has been increasing in the country and is expected to rise, the leading cause of this is that close to 50% of A-level finishers are opting into further studies. This has a powerful impact on the perception of degrees and by extension universities as the number of graduates have outgrown the number of degree-essential roles in the UK, leaving close to a third of graduates in roles which do not require a degree (Chartered Institute of Personnel and Development, 2015; Clegg, 2017). This issue is not a unique issue to the UK, but a global one, with the general expansion of higher education across Europe with the graduation rate rising from 18% in

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[1] Total population in 2017 was 66 million (Office for National Staststistics, 2015)
[2] Total population in 2002 was 60 million (Office for National Staststistics, 2015).

1995 to a high of 38% in 2012 with it being expected to follow the same trend of the UK. An interesting quote explains it well;

> "In most countries of the OECD, a higher education degree is the qualification most frequently required in jobs today. The composition of jobs in advanced countries has also consistently shifted over the past decade towards the employment of more highly qualified people at the expense of the less qualified. While parts of this trend are due to the rising job-skill requirements, it has been made possible by the greater supply of people with higher qualification coming into the labour market". (Chartered Institute of Personnel and Development, 2015)

With basic market theory, it is possible to see that the rising supply of qualified graduates could promote the stagnation in wages as there is greater competition for the number of places available. As the flexibility of prices, in this case, are partly dependent upon supply and demand (Biagi, Castano Munoz, & Di Pietro, 2020). This has the pronounced effect that jobs which where reserved for none-graduates and becoming highly competitive between more recent graduates due to how over subscribed some degree programs compared to their job available to graduates (Lauder & Mayhew, 2020).

A recent European Commission Report found that Europe (members of the European Union) experienced mismatches in the higher education labour market but found that it is made of two halves. On the one hand, a large proportion of highly educated graduates are unable to find a job or are in an occupation for which they are over-qualified or in a field they have not studied. The second more important part is that many companies have significant struggles to fill vacancies (Biagi, Castano Munoz, & Di Pietro, 2020), further pointing towards a skills mismatch between graduates and the expectation from employers. Any skills mismatch is only approximate as there is no standard way of measuring this, economists rely upon wage differentiation and wage growth as indicators towards shortages or surplus within a given fields (Gambin, et al., 2016).

2.2.2 Academic Attainment Between Science and Humanities

The clear divide between some students within the job market leads very well into the division between science and humanities. This division has always been a factor in higher education, and in 1956 Charles Percy Snow (C. P Snow) delivered a lecture at Cambridge discussing the 'The Two Cultures'. This lecture series discusses the view that since the Victorian era, humanities have been over-rewarded at the expense of scientific education and engineering[3]. This lecture and the subsequent literature has been highly influential in western discourse about higher education (Snow, 1959; Massey, 2018). One quote sticks out about C.P. Snow's views;

> "A good many times I have been present at gatherings of people who, by the standards of the traditional culture, are thought highly educated and who have with considerable gusto been expressing their incredulity at the illiteracy of scientists. Once or twice I have been provoked and have asked the company how many of them could describe the Second Law of Thermodynamics. The response was cold: it was also negative. Yet I was asking something which is about the scientific equivalent of: 'Have you read a work of Shakespeare's?'
>
> I now believe that if I had asked an even simpler question – such as, What do you mean by mass, or acceleration, which is the scientific equivalent of saying, 'Can you read?' – not more than one in ten of the highly educated would have felt that I was speaking the same language. So the great edifice of modern physics goes up, and the majority of the cleverest people in the western world have about as much insight into it as their Neolithic ancestors would have had" (Snow, 1959).

The divide between science and humanities has become less severe since 1958 as much more interdisciplinary work (Jacob, 2015) has taken place and more encompassing courses become more widely seen in higher education. As the divide has been lessening in higher education, the divide between the sciences and the humanities have been widening within public perceptions (Brown, 2018). With the view studying humanities, on average, does not offer graduates the same initial employment opportunities. Many reports show this, showing that generally, the pay disparity generally between science and humanities is noticeable (Education D. f., 2016; Burning Glass Technologies and Strada Institute for the Future of Work, 2018). The reports show that even though the employment rate between science and humanities have been consistently similar this does not paint the whole story surrounding these degrees.

[3] We now refer to scientific education as STEM (Science, Technology, Engineering and Mathematics)

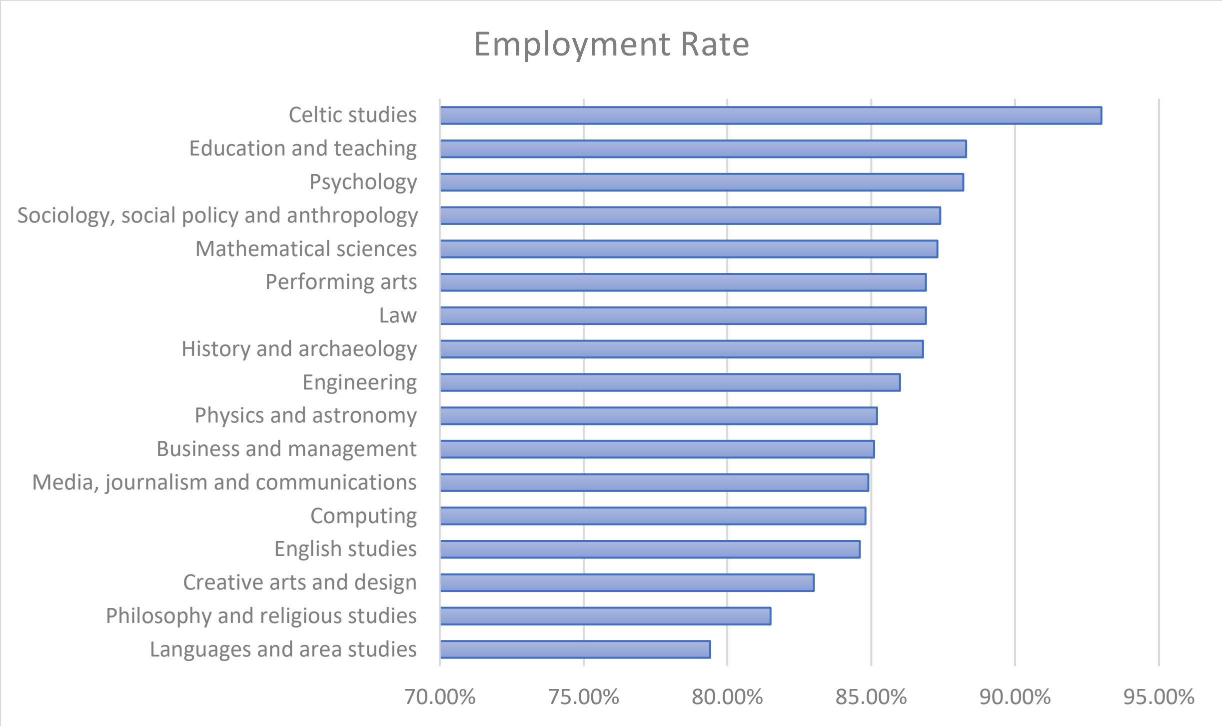

Figure 1: Figure displaying the percentage rate of employment for graduates in given fields (Department for Education, 2020).

The main point of concern is the difference in incomes between graduates that have either studied a science or a humanity subject, with engineering & technology earning, on average, £31,500 compared to a language graduate who would be earning £25,000 on average.

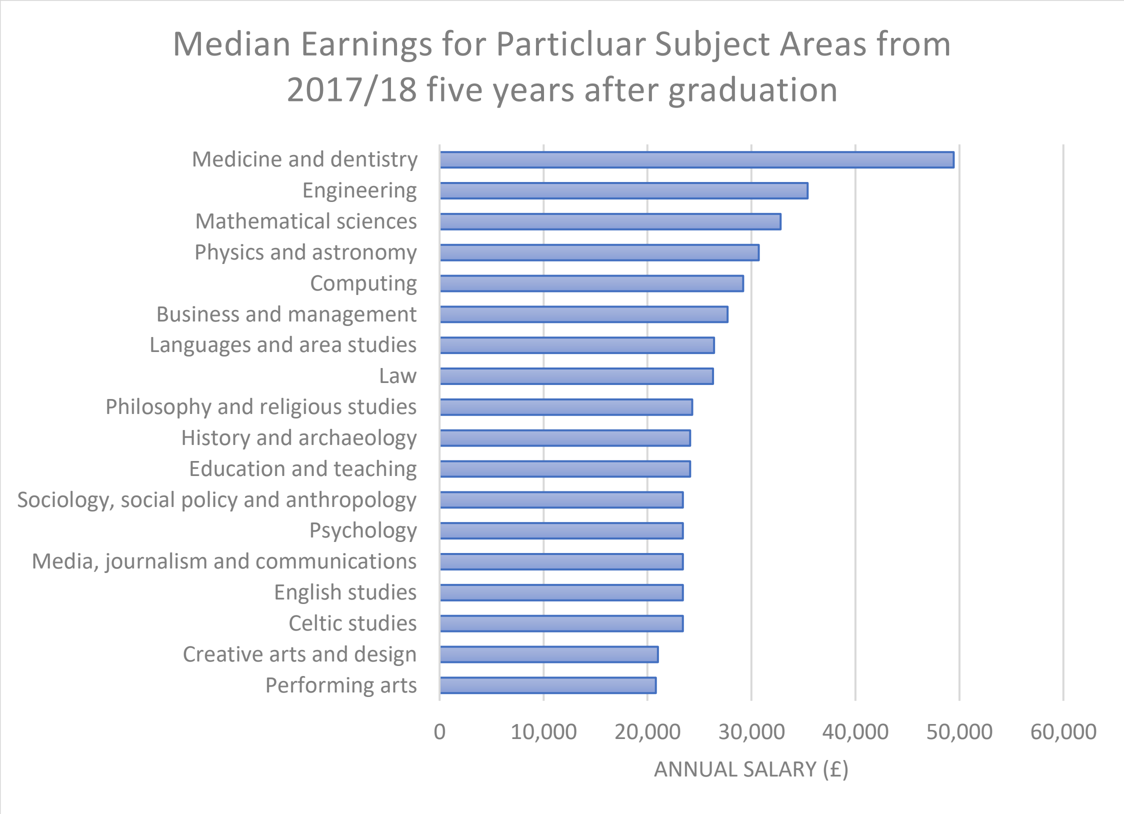

Figure 2: Figure displaying the annual salary for a graduate for particular subjects (Department for Education, 2020)

This disparity is massive and can add up to tens of thousands of pounds over someone's lifetime. This trend within the differences between average wages points towards concerns that humanities are oversubscribed at universities for the current demand of the workplace based upon the lower salary income after five years compared to sciences. This has the potential to show that different disciplines and skills have different marketable values, and this contributes to the median earning differences shown in figure 3 and can be supported by the general market theory discussed previously which salaries are usually determined by availability of suitable candidates for the job, fewer candidates than positions mean employers are competing for suitable employees driving up wages to keep such a person with their business.

2.2.3 Academic League Tables

The primary way for students to find an appropriate institution and compare them is by using online academic league tables. Currently, there are many academic league tables which rate universities upon their own predetermined factors such as;

- Academic performance of past graduates.

- Academic research quality from academics.
- Student satisfaction.
- Academic entry requirements.
- Student and staff ratios.

There are many more points such as research intensity, graduate prospects, and academic spending per student. These points are gathered yearly to inform a universities position when compared to others either across the world or country in the aim of helping students find the universities which would suit their needs and academic potential.

Organisational ranking can serve as an essential tool to supply information to both consumers and policymakers; the primary being grading quality while also providing an incentive for these organisations to improve. However, many of the academic league tables fail to provide empirical justification for the measures they use within their analysis and therefore is a highly unreliable method in which to compare institutions (Dill & Soo, 2005). Along with that, many of the popular league tables are run by commercial entities, specifically newspapers, each of which have a vested interest in volatile league tables as this makes for good news stories and increases interaction with their publications (Merrifield, 2018). The main league tables within the UK are The Complete University Guide (The Complete University Guide, 2020), the Guardian (The Guardian, 2020) and the Times Higher Education (Times Higher Education, 2020). There have been claims that the methods used for university league tables would not be accepted by journalists if it were used to create a league table of new publications in the same way they apply it towards higher education. League tables do not promote efficiency as higher per-student spending is rewarded with higher scores; this assumes that all universities are as efficient, which is not an argument which can be easily defended (Oswald, 2001).

Further adding to this, research impact is one of the factors which is used to rank universities and is heavily weighted in the rankings compared to employability, but it is not clear that there is a causal link between research prowess and employability (Christie, 2016), but research prowess could affect public opinion of an institution and therefore their brand image (Panda, Pandey, Bennett, & Tian, 2019). Long term effects of accurate representation within league tables can start to paint a false image of an institution which could either be outperforming or underperforming adjacent universities within any given table (Turnbull, 2019). An additional aspect which is not discussed within league tables is how brand recognition affects employability of students and how this is independent of short-term league table positions, and the potential affects brand recognition of institutions can have on league table position (Rodrigues, Atchiamith, & Aswell, 2020; Dennis, Papagiannidis, Alamanos, & Bourlakis, 2016).

The primary issue with league tables is that they put too much emphasis upon the many institutions to attempt to 'improve' in some areas which these league tables track; this could be improving their academic grades, therefore putting pressure upon institutions to give higher graded honours degrees or pressure students to succeed (Davis, 2014). This is contrary to the idea that society should want to give institutions the incentive to set strict standards. These concerns promote a version of academic grade inflation where course leaders adjust on their grading criteria in favour of their students, therefore bringing down the standard needed to reach a given grade and contributing to a whole host of issues which now face higher education (Docheff & Haddon, 1999). It is inherently easier to manipulate with coursework than through timed examinations, but on the other side of this, it could be argued that examinations could have been unfair to some students which could not memorise information or perform well under stress (Crumbley, Flinn, & Reichelt, 2010).

The increase in academic grade inflation can be continually seen within UK universities since the 2000s and is evident when looking at the classification of degrees over the last 13 years;

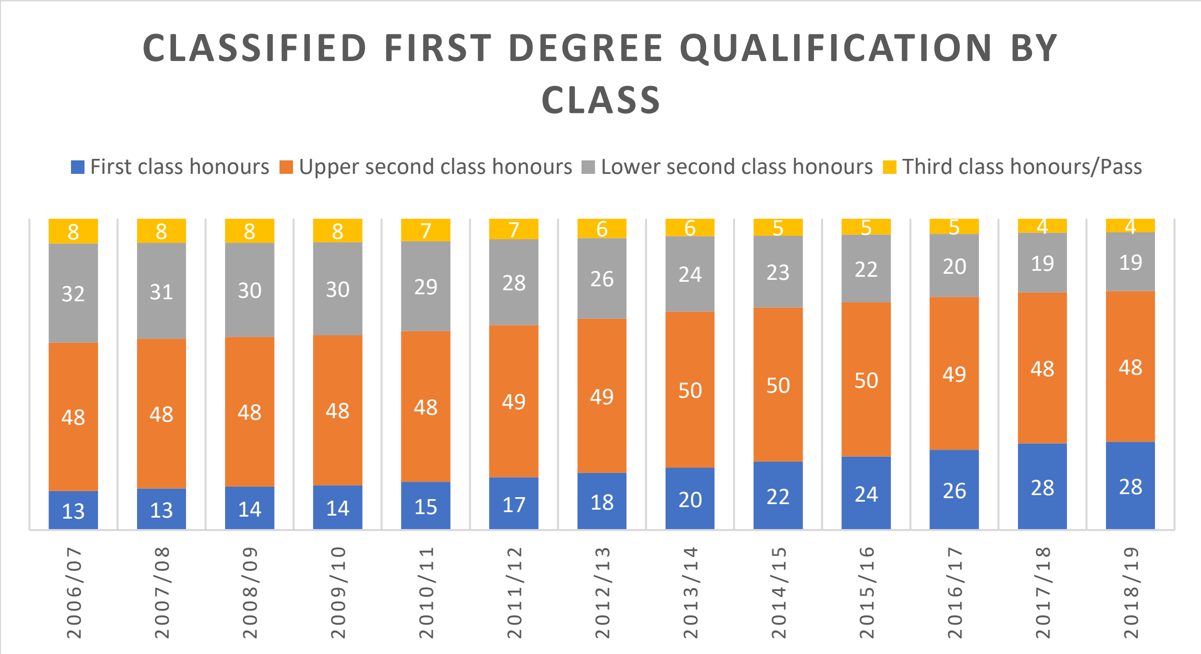

Figure 3: Percentage of first-degree qualifiers obtaining each classification, data gathered from hesa.co.uk.

The dramatic shift in the percentages of each of the different classifications could be putting trust in higher education into doubt. In Figure 1, the percentages of the lower second-class and third-class honours have been decreasing year on year while the percentages of first-class honours have increased by over double in the same timeframe. An improving educational system could partly explain this. However, one would expect the percentages of each classification to hold steady around a few percentage points of its mean, and such change highly suggests some higher educational institutions are inflating their grades as the belief that a graduate's achievement is equitable to their quality and therefore improves the institutions' reputation (Bachan R. , 2017). This trend has the potential to damage the value of honour degrees (UK Standing Committee for Quality Assessment, 2017). This upwards trend has been a cause of great concern for the government and has gotten the attention of The Office for Students which produced an in-depth analysis upon this showing that many institutions have unexplained results for providing first-class degrees with newer institutions providing higher rates of firsts than Oxford or Cambridge university (Office for Students, 2020) with the chief executive stating;

> "Overall, this data represents a mixed picture. It may well be that factors we don't account for in our modelling, including improved teaching and learning, have driven some of the increase that we have seen in recent years. There are also some striking changes at some of those universities which had previously awarded high proportions of firsts, although there is

> increased evidence of an unexplained increase in firsts at 73 per cent of universities." - (Dandridge, 202)

The Office for Students is starting to take steps to hold institutions accountable for an unexplained increase in academic grades, and this should go a long way to help reverse the falling trust in higher education (Lapworth, 2019).

Many reports and articles have argued that the upward trend in the proportion of the top classified degrees could be due to the modularisation of degree programs which changed methods of assessments from traditional exams to coursework and assignment, without any significant changes in grade boundaries (Bachan R. , 2017; Elton, 1998). Inflated grades can mask differences between student ability, and post-educational institutions must deal with the issue of inflation, making it challenging to select the best students or graduates for their roles (Richmond, 2018).

2.2.4 Ambiguity of Degrees

With the university complex increasing in size during the last twenty years, this has meant that the number of degree-granting institutions within the UK has increased from 24 institutions in 1958 to 47 by the end of the 1960s and increasing to an all-time high of 108 in 2010 (Tight, 2011). The increase of modularisation of courses, it has allowed many institutions to vary the content within their course to differentiate their degree program for prospective students (French, 2015). The variation has allowed for better personalisation for many students, as this allows them to find courses that could potentially cover their interests in each subject in greater detail. With the increase in specialised degrees, means that degrees that hold the same name may not teach and cultivate the same skills.

Taking the ambiguity further, different higher educational institutions have different entry requirement for similar or same named courses, even though these courses are meant to be comparable. One would expect that studying at an institution that has higher-grade requirements would give a student a higher probability of obtaining a first-class degree. This idea is far from the truth, with institutions with high entry tariff requirements awarding fewer first-class degrees than universities with lower entry requirement (Hindmarsh, 2018). This can be further shown when splitting universities into three groups; pre-1992, post-1992, and post-2003, where the unexplained increase in 'good' honours degrees[4] is considerably higher in post-1992 and post-2003 institutions. This gives the impression that these institutions are awarding good degrees in larger numbers than pre-1992 institutions, which are usually placed among the top universities in the country (Boliver, 2015; Bachan D. R., 2018).

The lack of consistency makes it incredibly hard for students to equate degrees from different institutions, due to module choices they may offer, to help make the best-informed decision about which course of study would be best for them. As for employers, this makes university degrees much harder to trust when there is little to no regulation, as a student who achieved a 2nd class degree could have better skills and subject knowledge than a student who got a 1st from a different institution (Hindmarsh, 2018).

2.2.5 How Does This Point to Increased Pressure?

Each of these issues that higher education institutions are facing is pointing towards that improvements will need to happen in the coming years; tackling the problems discussed above. As without such improvement, higher education as a sector could start facing more difficult times. Changes such as grade inflation, rapidly increasing student numbers over the last 3 decades, and the disparity between Science and humanity subjects being the main factors. The drop in confidence in higher education over the years can be directed towards the increasing student numbers compared to 15 years ago, with one survey stating that 66% of respondents believe that focus on higher education rather than technical skills is to blame[5] (Hudson & Mansfield, 2020). This could have potential repercussions within the differences in subject pedagogy and skill employers are looking requiring (Hennemann & Liefner, 2010).

The lift in student numbers has not helped this position at all as under the successive UK Governments; the higher education sector has become much more commercially focused and must operate very much like a for-profit business. Viki Cooke, a recent Pro-Chancellor of the University of Warwick remarks:

> "We have seen quite a bit of competitive behaviour that is undesirable, with quite naive marketing tactics to attract more students. We then wonder why higher education is treated

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[4] 'Good' honours refer to a degree classification of an upper second class or higher.

[5] Skills usually learned during an apprenticeship such as becoming a plumber, electrician, or skilled member in the building trade.

> as a commodity. We need to change the overall narrative about the value that higher education brings to society" (Hudson & Mansfield, 2020).

The response from universities needs to be quick and highly visible to recapture the public's attention and trust in higher education. This could be done in a multitude of ways:

- Emphasising academic standards (which could be argued have been dropping due to academic inflation) and reversing academic inflation. This would put more faith in the academic grading system and would allow employers to distinguish between students' abilities and aptitudes easily.
- Work with employers to close skills gaps through changing the curriculum to be more relevant to employment needs (Kevin Lowden, 2011), bringing them back in line with each other would only be a good thing.
- Review the concern of the cultural and employable differences between sciences and humanities with the potential of making cross-subject studies much easier allowing students to develop a more well-rounded skill set (Holley, 2017).

This is not an exhaustive list of things that could be reviewed but could be the main points with the most substantial impact upon higher educational standards and therefore help increase public trust again. This information shows that higher education in its current form is not perfect and improvements could be made to ensure higher education's reputation remains untarnished as well as providing all stakeholders with a more transparent method in which an individuals skills, grade and overall qualifications could be evidenced.

2.3 Development of Recordability of Transferable Skills and Changing Higher Education Policy

2.3.1 Change in Higher Educational Policy for Transferability

Many higher education institutions and governments have, over the last $20 - 30$ years, banded together to make their system more comparable. International cooperation has sparked many processes or accords, all with different aims and approaches. The oldest of these processes is that of the Washington Accord, which was established in 1989, and has 20 signatories (Alliance, 25 Years Washington Accord, 2014). The Washington Accord was developed at recognising that there is a significant overlap between the signatory nations. The premise is that students from these countries have met the academic requirement to practise engineering in any of the signatory nations. This is one of many accords currently, additional ones are the Sydney Accord for engineering technology, Dublin Accord for Engineering Technician qualification, and Seoul Accord for professional computing and information technology undergraduate degrees (2008) (Engineering, 2020). These Accords all focus upon different aspects of STEM subjects and show that higher education is making a unified effort to attempt to establish agreed-upon standards. Since these agreements are small when compared to the vast size of higher education, there is a considerable amount of work to be done if similar global accords are to be developed for other subjects.

These challenges have not stopped the European Union from attempting much more ambitious projects, with the aims of making standards and quality of higher education qualification comparable across the European economic area. The Bologna declaration (1999) proposes that students from the European Higher Education Area (EHEA) could move freely between countries using their prior qualifications as requirements for further study in another country (European Higher Educational Area, 1999), alongside the implementation of a three-cycle framework which oversees higher educational qualifications into three distinct levels (European Higher Educational Area, 2005). These levels cover undergraduate study, which is done traditionally without placements and takes three years; Master’s studies, which can take between one and two years; and then Doctoral studies which have no time limit as they can take many years.

Like all the current Accords, the Bologna Process is not a legally binding treaty or convention; this makes participation and cooperation voluntary (Council of Europe, 2020). The lack of legal bounds can create the impression that higher education is heading for a unified approach. Still, without an overseeing body that can regulate and investigate the compliance of its signatories, there is very little motivation for many institutions to change to such a position. The lack of motivation, therefore, makes the process take much longer than it could otherwise.

Even given the concerns about compliance, many signatories have started to work upon complying with this approach. These changes can be viewed within parts of Europe and Russia, which both previously only offered degrees of five years or more which would be considered by the three-cycle framework to be equivalent to a master's degree (Kouptsov, 2000; Rauhvargers, Deane, & Pauwels, 2009). Given that the Bologna Process centres upon Europe and limited nations outside of that, it means many countries, including the top three largest higher educational systems[6] lay outside of this process. This demonstrates that the process is having a large effect on Europe's higher educational institutions but is lacking a consensus on how to deal with higher education on a global level.

Any substantial change is bound to meet opposition, and the Bologna Process is not any different. There has been criticism stating that such changes have been developed and pushed forward for economic gain within European institutions. Therefore, promoting the enlargement of the scale of the European higher education system; could be an effort to change education for economic gain (Lorenz, 2006).

Further to this, the Dearing review (Dearing, 1997) concluded that higher education has been changing rapidly since the previous Robbins report (Robbins, 1963), taking into account that;

> "Demand for higher education from suitably qualified applicants of all ages is growing as more people achieve qualifications at level 3, and more of those who already have higher level qualifications look to upgrade or update them" – Dearing Report.

[6] These systems are universities in the United States, India, and China each with 19.9 million, 37.4 million and 30.3 million. (Goverment of India, 2019) (China Education Center, 2020) (National Center for Education Statstics, 2019)

With further observations made on some of the changes expected within the next 20 years of higher education, such as safeguarding the rigour of its awards and ensuring that the UK qualifications meet the needs of UK students. This does not mean that all recommendations within this report have not been acted upon such as;

> "Adopt a national framework of awards with rigorously maintained standards, with the academic community recognising that the autonomy of institutions can be sustained only within a framework of collective responsibility for standards, supported by the active involvement of professional bodies" – Dearing Report.

This recommendation led to the creation of the Quality Assurance Agency (QAA), which is an independent body that checks on standards and quality within UK higher education (Quality Assurance Agency, 2019). The QAA checks how universities, colleges, and alternative education providers maintain their academic standards and quality. This is done through external review; the reviews check for compliance with the Quality Code and advises the Privy Council on the right for a new institution to award degrees (Quality Assurance Agency, 2018).

With many of the current bodies or institutions relying upon the formal accreditation of qualifications, and the Recognising and Recording Progress and Achievement (RARPA) aims to change this (Education and Training Foundation, 2020). RARPA is the process that measures the achievements of students on non-accredited learning programmes (Learning and Skills Council, 2005). These measures aim to increase the consistency of educational achievement so that learning from different parts of the learning sector can be more easily compared.

The Higher Education Achievement Report (HEAR) has encouraged a more sophisticated approach to record student achievement, which acknowledges the full range of opportunities that higher education institutions can offer to their students. HEAR was commissioned on the back of recommendations that universities need to be more transparent and provide a more comprehensive record of student achievement (Universities UK, 2007).

2.3.2 Professional Accreditation and Oversight

Professional accreditation of a university course first starts with meeting the requirements set forth by QAA for the minimum expectations of quality required of a degree course. The requirements are set forward in subject benchmarks (Quality Assurance Agency, 2020). These benchmarks state the minimum requirements and expectations of graduating students from a programme of study and therefore tries to ensure that all students, no matter the education institution, gain similar skills and have undergone a comparable programme of study (Quality Assurance Agency, 2018).

To further protect the quality of university programmes, there are similar oversight bodies to uphold the quality standards within the European Higher Education Area. The central bodies are the European Association for Quality Assurance in Higher Education (ENQA) and the European Quality Assurance Register (EQAR) (Education E. A., 2013; European Quality Assurance Register, 2018). These bodies have similar mission statements to that of the national QAA to ensure that across Europe, all degree programs meet a minimum requirement to be equivalent.

As the QAA sets the minimum requirements for a degree course, many institutions go much further and seek academic accreditation for their course from additional external bodies. These bodies usually cover a particular subject area in much detail and provide additional qualifications within their subject area. The professional bodies considered within this study are listed in Table 2;

SUBJECT	SUBJECT FIELD	ACCREDITATION BODY
COMPUTING	STEM	BCS, The Charted Institute of IT (BCS, 2020)
ENGINEERING	STEM	Institute of Engineering and Technology (IET, 2020)
ACCOUNTANCY	STEM	Institute of Chartered Accountants in England and Wales (ICAEW, 2020)
MARKETING	Social Science	The Charted Institute of Marketing (CIM, 2020)
PSYCHOLOGY	Social Science	The British Psychological Society (BPS, 2020)
LAW	Humanities	The Bar Council (BAR, 2020)
LANGUAGES	Humanities	The Chartered Institute of Linguists (CIOL, 2020)

Table 2: Table displaying subjects, subject fields and accreditation bodies used through the methodology.

A point of note is that the Engineering Council is the UK regulatory body for the engineering professions and ensures that The Chartered Institute of IT and Institute of Engineering and Technology have sufficient experience to assess competence, monitor continuing professional development and monitoring professional conduct of their members (Engineering Council, 2020).

Professional body requirements are much more detailed and build upon the learning requirements set forth by the QAA. These accreditations can be given to a particular programme of study to validate that the course meets the high standards set forth by the professional body; informs potential students and employers about potential pathways into additional professional qualifications. For a course to be potentially certified by a professional body, it requires the institution to self-report their learning outcomes and proficiency while also undergoing an inspection of their course.

2.4 Skill Frameworks

The QAA and professional bodies are maintaining the quality of standards for higher education programmes, but standards are only to reach a minimum standard prescribed by the professional bodies, therefore does not consider the specific skills obtained on a programme of study (HEBRG, 2012). There are many skills frameworks that have different levels of detail and overall aims. A current framework that is used within education is Bloom's Taxonomy (Forehand, 2010) which has provided considerable help developing learning outcomes and being able to 'rank' these learning outcomes with the potential difficulty of meeting the requirements given within the learning outcomes. The following figure details the hierarchy of skills and associated difficulty;

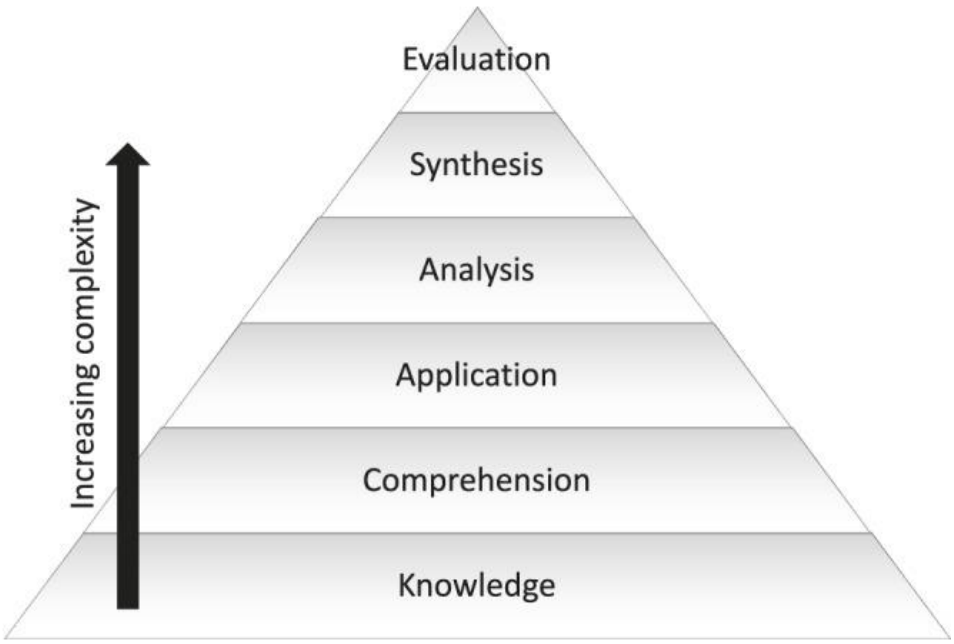

Figure 4: Bloom's taxonomy triangle, detailing the hierarchy of skills (Adams, 2015).

This taxonomy stems from the idea that some learning tasking is more difficult than others. Taking an example from primary education, knowing the multiplication tables by memory is very different to having to apply multiplication to word problems (Adams, 2015). Basic multiplication is very much in the knowledge category as it requires recall given a multiplication, while solving word problems involving multiplication is much higher up the hierarchy, as it requires comprehension, application, and analysis skills which are higher-order skills.

Knowledge is a simple recall task which is the retention of discrete pieces of information such as the timetables, definitions, or facts (Seaman, 2011). Knowledge is simple to assess using multiple-choice questions which require the retrieval of information. Comprehension can be evidenced by learners through paraphrasing of information, explaining to others or classifying items. Comprehension requires much more cognitive processing than remembering a simple fact; therefore, learners should be able to incorporate newfound comprehension into their knowledge base.

Further up the hierarchy, there is analysis which is strongly associated with critical thinking skills by being able to break information down into their parts and determining which are the most useful for solving the problem before them. Above analysis is synthesis which involves putting together elements from a complete image, idea, or piece of work (Ormell, 1974). The final two categories within this taxonomy are synthesis, which is interesting creating something new from prior information and evaluation is concerned with reflection upon their own work with the aim of improving it in a multitude of ways (Amer, 2006).

Bloom's taxonomy has been used extensively in education to help prepare exams for students to assess if they understand a topic at the different levels required for competency. Other work has been done to use this taxonomy to develop a specific set of learning outcomes in each of the categories to help improve communication within the department as well as having the potential of using used to strengthen the accreditation associated with the course (Starr, Manaris, & Stalvey, 2008).

Another key framework is that of SFIA (Skills Framework for the Information Age) which is a large and very well-developed framework that has become a global standard for employers wanting to gather more information about skills used by their workforce (SFIA Foundation, 2015). SFIA follows a similar approach to Blooms Taxonomy providing different levels of skills, determining how difficult they could potentially be, but the main difference being the second dimension that this framework has, which is a list of skill areas. This can provide a very detailed view of an individual's particular skill set. For this study, this framework is far too vast to be able to apply as it currently consists of 97 different skill areas. SFIA framework is much more detailed for business applications which envelops considerably more specific skills than the 21st-century skills framework which is centred around education.

2.5 Recording Transferable Skills

As discussed previously, there are currently many different frameworks spanning professional bodies, QAA, SFI and curriculum frameworks; all these frameworks tend to approach transferability of skills within a given discipline, making them extremely difficult to use in either cross-disciplinary jobs or when attempting to assess an individual's skill from a completely different area of work. To fill the gap which these established frameworks inherently have, the 21st-century skills framework was developed. 21st-century skill framework (Dede, 2009) primary use is within education and provides very generic skill areas which are considerably different from 20th-century skills (Barell, et al., 2010) due to how technology and the internet have shifted jobs from manual labour to other skilled professions (Christensen, 2010). The need for new sets of skills is due to the emergence of very advanced information technology, as discussed before, and is changing the way people work with some jobs now being completed by machines. The 21st-century framework is split into four different main skill areas (BattalleforKids, 2019);

- Life and Career Skills.
- Learning and Innovation Skills.
- Information, Media, and Technology Skills.
- 21st Century Themes.

These have been identified as the main themes which an individual needs to be competent in to succeed in the age of the internet. Industries are now regularly evolving with new ideas and methodologies (Ross A. , 2016). Therefore, students need to learn to adapt to such changes within the labour market. At the very least, they need to learn how to react to it and record their transferable skill set. These skill areas can be further divided into particular skill areas for a more granular view;

Career and life	**Learning and innovation**	**Information literacy**	**core subjects and 21st-century skills**
Initiative and self-direction	Creativity and innovation	Information Literacy	Financial, economic, business, and entrepreneurial
Leadership and responsibility	Critical thinking and problem solving	ICT literacy	Civil literacy
Flexibility and adaptability	Communication and collaboration	Media literacy	Environmental literacy
Social and cross-cultural skills			Global Awareness
Productivity and accountability			Health Literacy

Table 3: Table displaying how each different skill is assigned to a category.

This list of skills is much more generic than that of SFIA. This makes SFIA a poor choice to directly apply to an educational setting without significant changes. As for education, 21st-century skills have been used within education and have been considerably researched regarding their suitability as a reliable framework (National Research Council, 2012; OECD, 2014; Clinton, Purushotma, Robison, & Weigel, 2016).

Referring to table 3, it is possible to see common themes of skills; Understand, Context, Solution, Delivery, Behaviour and Reporting, based upon Bloom's taxonomy. These skill groups can be represented with a letter which represents the different level of skills within Bloom's Taxonomy which can be seen with the Understand and Context being models upon Knowledge and Comprehension, Solution and Delivery being modelled upon Analysis and Application, and Behaviour and Reporting being modelled after Synthesis and Evaluation. The use of letters allows for the grouping of skill areas into 3 distinct areas explained as;

- A & B – Understand and Context.
- C & D – Solutions and Delivery.
- E & F – Behaviour and Reporting.

The 21st-century skills framework is applied and used to inform the processes within the methodology. This lettering shall be referred to further within this thesis and particularly within the methodology chapter.

2.6 Micro-credentialing as a New Way of Addressing the Impact of Globalisation, Changing HE Landscape and Changes in Policy

Physical badges also referred to as honours or awards, have been used for centuries to represent an individual's accomplishment or performance within a particular task or situation. Badges date back to the middle ages, with the most common uses being to signify that they completed a pilgrimage or allegiance for faction or political party. The use of badges has remained a constant throughout the ages with specialist badges worn by officials, soldiers, and servants (Koldewed, 1999).

Furthermore, some modern organisations have used this award model, such as Scouts and Girlguiding (Scouts, Scouts badges and awards, 2019; Girlguiding, 2019). Scouts and Girlguiding's goal are "to contribute to the development of young people in achieving their full physical, intellectual, asocial and spiritual potentials as individuals, as responsible citizens and a member of their local, national and international communities" (National Scout Associations, 2011). The use of badges has allowed these institutions to help children of various backgrounds to develop a diverse set of new skills in a short space of time and reward them with badges, these are Scout specific but other organisations have placed value upon these badges due to the transferrable skills they encourage and by extension make people who have achieved them more appealing applicant for a job (Scouts, 2020). These badges can then be displayed on their club uniform to show that they have met the proficiency for that given badge and can help boost their confidence in other skill areas. Considering that these badges can be earned in a short period, this has allowed for gamification of learning objectives to keep learners interested, attrition within their groups to a minimum, and promotes that learning can be fun (Scouts, Scouts Activities, 2019).

The way scouts and girl guides have approached the development of new skills is in complete contrast to that of education, where traditional educational systems rely upon the fixed end of year exams to accredit students. The increasing demand on schools is being acknowledged by Ofsted themselves;

> "For a long time, our inspections have looked hardest at outcomes, placing too much weight on test and exam results when we consider the overall effectiveness of schools. The cumulative impact of performance tables and inspections and the consequences that are hung on them has increased the pressure on school leaders, teachers and indirectly on pupils to deliver perfect data above all else" (Spielman, 2018).

This has given the acknowledgement that the outdated assessment system needs the same reform as higher education. A multitude of organisations are actively researching new credentialing systems. More recently, the focus on alternative accreditation has been from private businesses rather than educational institutions (Creative Skillset, 2013). They have produced courses, outside of education, which have become highly respected by potential employers and many higher educational institutions (DofE, 2019; OpenBadges, 2019). These courses are short in comparison to traditional educational courses. These courses, therefore, only assess activities that need to be completed to satisfy distinct learning objectives. This level of specificity ensures that a student develops the knowledge, or the skills expected.

In 2011, The Mozilla Foundation announced their intent to develop an open framework called Open Badges; which will build a system for the simple issuing and displaying of digital badges for a transparent view into an individual's achievements (Surman, 2011; Udemy, 2019). Throughout the following few years, OpenBadges became an enormous success with 1,450 organisations issuing badges through their site and committing to further support for this platform through 2016 (Mozilla, 2016). This new area of work is a shift from traditional 'schoolwork' to that of recognising skills that cannot be achieved in the static confines of an educational institution. With higher education taking considerable time to change courses for the changing demand, open-source badges are filling the gap between obtained skills and desirable skills.

While OpenBadges have been open to academia and business and have shown that they have great potential, there have been multiple successful implementations of academic only purposes. The most successful of these is Udemy founded in 2007 (Udemy, 2019). There are also free alternatives like Khan Academy, which was founded in 2008 (Academy, 2019), being viable for individuals to learn new skills. These platforms have developed in different directions with Khan Academy placing a higher focus on gamification of studying, compared with Udemy which has stayed comparatively professional in comparison.

Even with the significant progress made by all these private business ventures, they are missing one crucial component which has been central to educational institutions; this is the idea of a minimum standard of quality. With all of the examples, the quality of their courses are set by themselves; in the beginning, this would be useful as it allows unilateral control over their courses and allows them to change their courses dramatically in short spaces of time to attend to business needs. The lack of oversight has significant implications such as the reliability of their accreditation, the difficulty of the course and grading criteria. Without confidence in these areas, it would make it difficult for many businesses to put faith in these emerging credentials without significant research into their effectiveness. One of the first attempts at producing a standard for micro-credentialing has been explored by the European MOOC Consortium. This would allow for many courses to be produced in the same manner, but the current framework is based upon workload and the expected number of hours to finish the course (European MOOC Consortium, 2019)

The use of badges is an educational currency to streamline administrative tasks like verification of qualifications, but with a better ability to track how people learn and understand skills acquired throughout their education and into their career. Without an effective means to balance and verify badge standards between different organisations, this makes the use of badges poor choice as a means of educational currency (Borrás-Gené, 2018).

Micro-credentialing is becoming a larger field of study within education. Micro-credentials serve as a ‘mini’ academic award which represents mastery of a well-defined array of skills or competencies. The approach for micro-credentialing has been explored in detail by Skill Builder Partnership but is not specific enough to be applied within a university course (Ravenscroft & Baker, 2020). This is almost the opposite of a university degree, which envelops a comprehensive set of interconnected skills which are usually evidenced with a transcript with no special connection to the learner’s competencies (Ross, 2016).

With students wanting to pursue any advantage they can get over their potential job rivals, they are increasingly turning to micro-credentialing along with other more traditional accreditations. This has caused an increase in popularity and demand for alternative credentialing in the last few years (Fong, Janzow, & Peck, 2016). This demand can also be magnified with the potential loss of trust that degree holders are equipped for the modern workplace. An increasing number of employers assume that graduates do not have the required knowledge to fulfil the job position competently. A potential, partial, response to this, is university graduates now amass a wide range of professional and educational certificates through a growing number of educational institutions and professional bodies (Centre of Professional Qualifications, 2015). Qualifications that once were at the forefront of accreditation have become commonplace, and in a sense have devalued these accreditations for the employer and the individual with the mass distribution of awards into the global job marketplace.

Therefore, micro-credentialing has become a field of focus for many institutions which are wanting to stay relevant in the increasingly active area of higher education, while also trying to rebuild trust with the business sector. Many institutions are developing alternative credentialing programs with 178 out of 190 institutions profiled in the USA provide alternative credentials to their students (Fong, Janzow, & Peck, 2016). This is because these alternative credentials allow individuals to validate their knowledge or skills to a prospective employer.

With micro-credentialing being in its infancy, many institutions are opting to develop elementary credentialing courses to limit their risk; one such program is from the Open University (The Open University, 2019). These courses are currently not focused upon areas of study which would traditionally be encompassed by a degree; this can be considered as a possible tactic to make sure that uptake on their degree courses is not eroded and their streams of funding are left uninterrupted

Due to degree courses encompassing the subject knowledge and focuses upon this, many institutions have determined that building short, un-credited (for the degree which the student is enrolled on) for transferable skills will be essential for a student's professional development (Mathur, Wood, & Cano, 2018). This would limit the risk to the institution if such a program were not deemed a success as such a program can be easily stopped with no effect on their degree programs. This neglects the approach of developing a system within the degree programme, which could be used in conjunction with the traditional transcripts.

2.6.1 Knowledge Engineering – Closing the gap between subjective learning outcomes and codified set of skills.

Currently, for machines, and indeed for academics, understanding the learning that takes place within higher education is ultimately is expressed as learning outcomes at a module level and then at a more macro level at the qualification level. These descriptors are poorly defined, with no standard way of expressing specific learning and a large amount of interpretation required to understand, let alone compare, learning outcomes between modules or courses. Given this confusion, it is problematic at best for either humans or machines to analyse learning effectively in a manner that can produce reproducible results, making the whole area of learning analytics for example extremely challenging.

In the field of knowledge engineering, in the mid-1980s, (Clancey, 1985) identified a general inference pattern, known as heuristic classification, which enabled observables to be abstracted to the Knowledge Level (Newell, 1982). Through the Problem-Solving Method, a clear process could be developed to move from observables to solutions, and in so doing goals, actions and knowledge could be clearly understood and defined. This would make comparing modules and qualifications.

In this study, the observables for the Problem-Solving Method are the learning outcomes of a module. Through the abstraction process outlined in this thesis these observables can be heuristically matched to solution abstractions consisting of 21st Century Skills categories and in so doing can provide a solution in the form of a skills profile for the module or a full course of study.

By demonstrating this approach, in principle, future work can be conducted which codifies, abstracts and models using artificial intelligence and machine learning techniques, as well as enabling academics to review this abstraction process itself and thus question and adapt their definitions and standards for learning outcomes to better promote both human understanding and machine extraction capabilities. In time this may lead to universal static domain knowledge for learning through a learning outcomes ontology based on 21st Century categories and an associate Expertise Model.

The Expertise Model would mean that learning outcomes could be automatically linked to 21st Century categories and through these to workplace competencies, providing a mechanism for both educators and employers to identify skills matches and mismatches. Whilst any further exploration of such concepts, processes and approaches is clearly beyond the scope of this study, it does indicate the broad utility of the approach not just within education and employment but also within knowledge engineering, artificial intelligence and machine learning more generally.

2.7 Summary: What does all this mean for high education and micro-credentialing for transferable skills?

As it has been shown that higher education has been undergoing considerable changes. If each issue presented individually, higher education would relatively be able to adapt to such changes. Unfortunately, this has not happened, and the plethora of issues which is facing higher education, such as increasing student number, rising number of good degree classifications, and lack of transparency between supposedly comparable degree courses. With many issues being tackled by the government or oversight organisations, this cannot be the only way which these issues can be solved, therefore research demand has increased into new areas which could help alleviate the pressures on higher education.

Current applications are being made for private businesses with the use of micro-credentialing badges. These have had great success, but have also had many flaws, such as no central standard for badges, therefore making them hard to trust as an alternative to traditional education. Additionally, current research is exploratory and limited in scope to show a proof-of-concept design that can be used to facilitate the existing degree structure. There has been little to no research into exploring the idea of applying micro-credentialing within a traditional degree programme without having to change or modify the delivery of the course. Implementing a credentialing approach could have the potential of improving the transparency of a particular institution's degree programme for all stakeholders.

Chapter 3

Methodology

The purpose of this chapter is to introduce the methodology for this research which is to study the distribution of 21st-century skills at two distinct levels of granularity. This shall show the distribution of skills gained while studying at higher education; this can be used by all stakeholders to reduce the uncertainty and ambiguity of their skillset. The study will be exploratory in nature as no comparable mapping solution has been developed for use within higher education.

The research philosophy used is that of epistemology, which is a branch of philosophy that is concerned with the study of knowledge. Within epistemology, there is a multitude of philosophical stances, and this research follows the interpretive approach (Saunders, Lewis, Thornhill, & Bristow, 2015). Interpretivism is characterised by using qualitative analysis over quantitative to obtain results and make sense of the data collected.

This research takes a deductive approach, and the hypothesis is validated through the analysis of the collected data. This is supported by a mono-method of qualitative data based on secondary sources gathered from professional bodies, government bodies and higher education institutions. This project provides a cross-sectional due to all the secondary data being the most up-to-date data available, and this research has been conducted over a short period of time.

The data collected from all secondary sources will be codified into a set of meaningful and cohesive categories that can be used throughout the project. Codifying data plays a significant role in analysing qualitative data. With codifying data, the first cycle is not entirely accurate due to how generic the professional bodies report their required learning requirements therefore at this level of reporting a lot of the finer details of a particular course is lost. further cycles can produce more accurate results, but for this research, a first cycle codification is more than adequate to show a distribution of skills from requirements (Elliott, 2018). Codification has been chosen for this project as all requirements presented by all bodies and module specifications give a list of learning outcomes which usually consist of a sentence and knowing which skill each outcome is developing or requiring will allow for much better analysis later.

The remainder of this chapter outlines how to develop a mapping of the expected skills cultivated within a particular programme at universities while also checking these against the professional bodies' requirements. This can then be used to see which skill areas each of the different programmes and professional bodies are focusing upon. The main aim here is to check if the programme specification covers all the 21st-century skills which have been a focus for many researchers within education and private enterprises.

Once the programme level has been conducted and reviewed for consistency, a module-level analysis is conducted at which the 21st-century skills are mapped to 6 subject-specific categories using a mixture of expected hours alongside learning outcomes to micro-credential subject content. 6 categories have been chosen due to the resemblance to Bloom's taxonomy as well as succinct enough that it would not require a lot of time to understand. This is to produce data that outlines the expected skills which would be developed throughout a particular program of study.

3.1 First Iteration Mapping – Programme Level

For the programme level, the learning outcomes or expected requirement are governed by the QAA, and if a professional body accredits a particular program of study, it will also have to meet the professional bodies learning requirements also. To ensure that a programme of study meets these standards, the QAA and professional bodies make frequent visits to institutions. These visits are usually short and entail review course/module specifications, students' submissions and other supporting evidence to confirm that the institution can meet the requirement set forth by the QAA. There is a similar process for the professional bodies, but each professional body does it in a slightly different way, although this is not a concern.

As learning outcomes are self-reported by universities and require moderation to ensure that the institution meets them, for this reason, the learning requirements set forth by the QAA and the professional bodies shall be used for this programme level mapping. This is to make the mapping as general as possible and covers all programmes with the same name across the UK. This also has the bonus of showing the average expected skills from someone who undertook this programme of study.

The following process outlines the order in which the mapping process shall take, this is due to the hierarchy of requirements on degree courses, as all degree courses must meet the QAA requirements but they do not need to be accredited. The process of working through the methodology can be seen in the following flow diagram, which outlines the sections which the methodology can be broken down into;

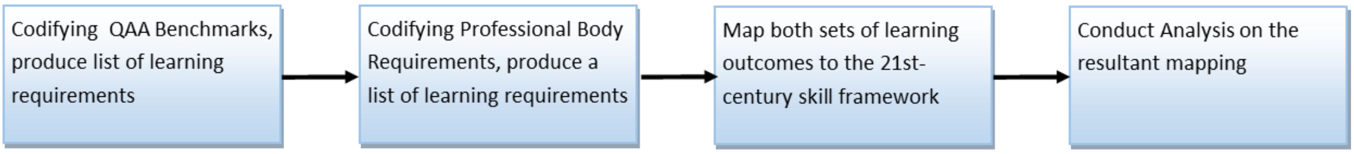

Figure 5: Flow Diagram displaying the critical sections of the process of producing a finished map for the first iteration mapping.

Gathering the QAA benchmark data, the data can be all found on the QAA website, www.qaa.ac.uk. This covers a vast quantity of subject areas and each subject benchmark statement follows the same format, making it easier to extract the list of learning requirements. All the requirements are typically listed under section three within most of the benchmark statements. This does differ depending on the subject area for how exactly it has been presented within the document, and the list of skills requirements are easy to follow and gather. This allows the production of a skill requirement list in the region of 20 with some subject areas producing many more learning outcomes and others producing less. This does not mean that a subject with many learning requirements is trying to cultivate more skills than a subject with fewer.

Producing a list of learning requirement set forth by specific professional bodies can be time-consuming due to the number of professional bodies within given fields. For this reason, chartered professional bodies have been considered as it allows for a better comparison between subject areas at the chartership level as well as determining if the QAA requirements for a programme support those of the professional bodies or have a different focus. The chartered institutions list the learning requirements for chartership and if they support its accreditation of degree programmes on their respective websites. These learning requirement lists are much larger than that of the QAA benchmarks and may consist of 50 or even more learning requirements. Due to the professional bodies being different, there is no standard to their documentation; therefore, data is much harder to find within the documentation, take much more time and care to gather these learning requirements.

Once a complete list of all the learning requirements has been compiled at the programme level, it would be time to map each learning outcome onto the 21st-century skills framework, including a modified version of Bloom's taxonomy for subject-specific learning requirements, producing the following table of containers and skills within them, with each container containing three or more skills;

Career and life	**Learning and innovation**	**Information literacy**	**core subjects and 21st-century skills**	**Subject Specific**
Initiative and self-direction	Creativity and innovation	Information Literacy	Financial, economic, business, and entrepreneurial	Theoretical knowledge
Leadership and responsibility	Critical thinking and problem solving	ICT literacy	Civil literacy	Process and production
Flexibility and adaptability	Communication and collaboration	Media literacy	Environmental literacy	Business requirements and applications
Social and cross-cultural skills			Global Awareness	Contextual analysis and evaluation (self-reflection)
Productivity and accountability			Health Literacy	Technical writing
				Innovation

Table 4: Detailing all the containers and skill areas from the 21st-century skills and the modified version of Bloom's taxonomy.

There are constraints with most mapping approaches, and this mapping is no different. There have been assumptions and decisions taken to make the mapping progress more uniform and repeatable for all professional competencies and to consider the differences between each accreditation body's approach to developing a list of required competencies. The decision was to make the mapping between accreditation requirements to the new modified list of skill areas to be a one-to-one mapping, as this would help reduce the complexity of mapping and still allow for accurate results to be gained. The possibility of a one-to-many mapping could be explored in the future, but that would be outside the scope of this project.

Using simple keyword analysis alongside contextual cues of each learning outcome, it is possible to map each learning outcome to one specific skill area with relative accuracy. Here are some examples of mapping for both general skills also some with subject-specific skills;

		EXAMPLE	REASONING
LIFE AND CAREER SKILLS	Initiative & Self-Direction	Carry out and record continued professional development (CPD) necessary to maintain and enhance competence in own area of practice. (Engineering)	Skills relating to the continuation of professional development, encompasses any skills and therefore not subject-specific.
	Leadership & Responsibility	Students should be able to identify and act per the core duties of professional conduct and professional ethics which are relevant to the course. (Law)	Skills that promote leadership and responsibility as either a singular member or as part of a group.
	Flexibility & Adaptability	The ability to challenge the status quo and drive change in a business environment. (Marketing)	Skills relating to the flexibility and adaptability of the application of their other skills.
	Social & Cross-Cultural Skills	Ability and willingness to engage with other cultures, appreciating their distinctive features. (Language)	The ability to effectively interact with others in diverse groups and situations.
	Productivity & accountability	Psychologists should when bringing allegations of misconduct by a colleague, do so without malice and with no breaches of confidentiality other than those necessary to the proper investigatory processes. (Psychology)	Managing own work with ownership by setting and meeting goals, even in the face of obstacles and competing pressures Prioritise, plan and manage work to achieve the intended result.
LEARNING AND INNOVATION SKILLS	Creativity & Innovation	Develop and apply new technologies. (Computing)	Creativity is creating something new and original, while innovation is the application of creativity.
	Critical thinking & Problem Solving	Be pragmatic, taking a systematic approach and the logical and practical steps necessary for often complex concepts to become a reality. (Engineering)	Problem-solving and critical thinking is the use of logical and rational thoughts, knowledge, and facts to effectively solve problems.
	Communication & Collaboration	Effective communication, presentation, and interaction (Language)	Collaboration and communication involve being able to effectively as a member of a team or produce documents which express the intended purpose.
INFORMATION, MEDIA AND TECHNOLOGY SKILLS	Information Literacy	location, extraction, and analysis of data from multiple sources, including acknowledging and referencing sources. (Accountancy)	Information literacy incorporates a set of skills and abilities which everyone needs to undertake information-related tasks
	ICT Literacy	computational thinking, including its relevance to everyday life. (computing)	The use of digital technology, communications tools to manage, integrate, and create information to function in a knowledge society.
	Media Literacy	**There is no learning outcome which has mapped to media literacy.**	Media literacy is the ability to understand the differences in media and understand the messages they represent.
CORE SUBJECTS AND	Financial, Economic, Business and Entrepreneurial	The ability to think ahead to spot or create opportunities and maximise them. (Marketing)	which involves knowing how to make appropriate personal economic choices, understanding the role of the economy in society, and using entrepreneurial skills to enhance workplace productivity and career options

Civil Literacy	Have an awareness of the wide range of organisations supporting the administration of justice. (Law)	The knowledge and skills to participate effectively in civic life through knowing how to stay informed.
Environmental Literacy	The ability to work in a way that considers its impact on other people, organisational goals, and the wider environment (Marketing)	An individual's understanding, skills and consideration of his or her relationships to natural systems, communities and future generations.
Global Awareness	be aware of the risk, cost and value-conscious, and aware of their ethical, social, cultural, environmental, health and safety, and wider professional responsibilities. (Engineering)	An understanding of how environmental, social, cultural, economic, and political factors impact the world.
Health Literacy	**There is no learning outcome that has mapped to media literacy.**	The ability to obtain, process, and understand necessary health information and services needed to make appropriate health decisions

Table 5:Table outlining 21st Century skills, examples, and reasoning behind this with examples from each of the different professional bodies learning requirements.

These are for learning outcomes which have their subject area knowledge as the leading learning requirement, also expected that a particular skill is not transferable between subject areas;

SUBJECT-SPECIFIC SKILLS	EXAMPLE	REASONING
THEORETICAL KNOWLEDGE	Understanding the principles of managing computing processes (computing)	Understanding of subject knowledge would not be classed as transferable knowledge.

PROCESS AND PRODUCTION	Use a variety of psychological tools, including specialist software, laboratory equipment and psychometric instruments (Psychology)	A process or activity which requires subject knowledge to complete or a way of doing something unique to a given subject area.
BUSINESS REQUIREMENTS AND APPLICATIONS	The ability to deploy appropriate theory, practices and tools for the specification, design and implementation of computer-based systems according to customer and user needs and use innovation and creativity in a practical and social context. (Computing)	Subject related tasks require an individual to take into account business needs specifically related to their subject.
CONTEXTUAL ANALYSIS AND EVALUATION	Remain aware of and acknowledge the limits of their methods, as well as the limits of the conclusions that may be derived from such methods under different circumstances and for different purposes. (Psychology)	The subject-specific reflection requires a good understanding within the field to complete adequately, this could be public perception, your professional actions which relate to the field
TECHNICAL WRITING	be able to communicate orally and in writing and draft and amend documents in a form, style and tone appropriate for the recipients and the context (Law)	Writing which is specific to the subject field and is not a transferable skill such as writing a legal document, engineering diagram/drawings or critically review with the context of the subject at the forefront.
INNOVATION	Contribute to the design and development of engineering solutions (Engineering)	The development of ideas specific to the subject area could be new ideas, implementations or research processes.

Table 6: Table outlining subject-specific skills, examples, and reasoning behind this.

Once the programme learning outcomes have been mapped to the 21st-century skills framework and a modified variation of Bloom's taxonomy, the spread of learning outcomes in each of the different skill areas allows for an overview of each programme area on which skills they prioritise.

The programme level mapping can later be used to check the validity of the results once the module level mapping has been produced. This is a method to check that both mappings be moderately equitable and therefore relatively accurate when taking into account that the two mappings have been produced using slightly different methods, along with different starting documentation.

3.2 Second Iteration Mapping – Module Level

For the module level, the learning outcomes are self-reported by universities within their programme and module specification; these outcomes are aligned with the QAA and professional bodies. These learning outcomes are usually much more detailed as these learning outcomes are specific to the university's programme rather than for the generic programme set forth by the QAA. Even though universities differentiate their modules within the confines of the requirements set forth by the QAA, this usually means that they add many more learning requirements within their modules. This iteration mapping requires that the university's programme and module specification be self-reported accurately as this will help ensure that the final mapping will be accurate for the course.

Very much like the first iteration mapping, the second iteration mapping can follow a similar process to produce a finished mapping solution;

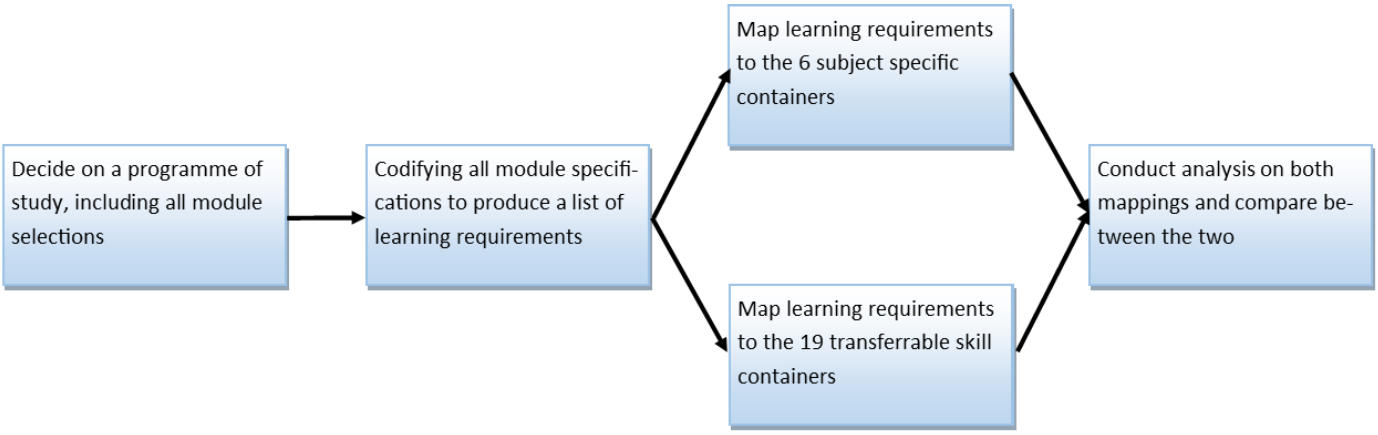

Figure 6: Flow Diagram displaying the critical sections of the process of producing a finished map for the second iteration mapping.

Taking the module information for the programme of study means making sure that the programme of study consists of the 360 credits it would require along with making sure that the prerequisites are met to ensure that the modules chosen can represent a full programme of study. Once the list of modules has been confirmed, the next step is to extract the learning outcomes for each module using the same techniques used upon the QAA and professional body documentation within the first interaction mapping.

As a module is comprised of different methods of assessing a student's particular proficiency with both subject-specific and transferable knowledge, this can be assessed through various methods. The potential pros and cons for each different assessment type are outside the scope of this project and could be a complete research topic on its own, with a different final score weighting. An example of this is two class tests of 10% each and one exam of 80%. It is evident that the 80% exam is going to be more pressing for students and therefore they would study more for this assessment. By association, more study has been conducted on the learning objectives tested within the assessment. By taking this feature into account, it is possible to develop an elementary weighting system for learning outcomes. Such a system requires;

- A simple mapping from learning outcomes to individual assessments; this is usually given within the module specification or could be easily extracted from the documentation.
- That there is a one-to-one mapping from learning outcomes to individual assessments.

Based on the literature and following the 21st-century skills carefully, it allows for two different mappings using the same module learning outcomes. The two mappings can be split into transferable skills and subject-specific skills, and this can be seen in the following table

COMPETENCIES (MICRO-CREDENTIALS)		SHORT DESCRIPTIONS
REFERENCE	**Subject Specific**	
1A	A - Theory	Self-explanatory encompasses theoretical knowledge of a subject area
2B	B - Business Requirements and Applications	Requirements that strongly focus on business needs.
3C	C - Innovation	A new idea, creative thoughts, new imaginations in the form of device or method
4D	D - Process and Production	A series of actions or steps taken to achieve a particular result, usually requiring the use of subject-specific knowledge.
5E	E - Self-Reflection	Context analysis is a method to analyse the environment in which a business operates.
6F	F - Technical Writing	Technical writing is a type of writing where the author is writing about a particular subject that requires direction, instruction, or explanation.
	Transferable Skills	
7A	A - Information Literacy	Information literacy is the set of integrated abilities encompassing the reflective discovery of information, the understanding of how information is produced and valued
8B	B - Business Alignment	All levels and players are clear about the organisation's purpose and make decisions in accordance with its aims and objectives.
9B	B - Entrepreneurship	Entrepreneurship refers to the concept of developing and managing a business venture to gain profit by taking several risks in the corporate world.
10B	B - Numeracy	The ability to use numbers and solve problems in real life. It means having the confidence and skill to use numbers and mathematical approaches in all aspects of life.
11B	B - Analysis	Analysis is the process of breaking a complex topic or substance into smaller parts to gain a better understanding of it.
12C	C - Creativity	The use of imagination or original ideas to create something.
13C	C - Problem Solving	The process of finding solutions to difficult or complex issues.
14D	D - Technical Proficiency	Must be able to apply the technical knowledge and skills required in the specialist and professional job role and responsibilities to achieve the expected outputs.
15D	D - Self-Regulation	Self-regulation can be defined in various ways. In the most basic sense, it involves controlling one's behaviour, emotions, and thoughts in the pursuit of long-term goals.
16D	D - Leadership	Taking the lead on a project; means being the lead on team building, team motivation.
17D	D - Management	Management is a set of principles relating to the functions of planning, organising, directing, and controlling, and the application of these principles in harnessing

		physical, financial, human and informational resources efficiently and effectively to achieve organisational goals.
18E	E - Professionalism	The status, methods, character, or standards expected of a professional or of a professional organisation, such as reliability, discretion, even-handedness, and fair play.
19E	E - Ethics	A set of concepts and principles that guide us in determining what behaviour helps or harms sentient creatures.
20E	E - Evaluation	The making of a judgement about the amount, number, or value of something; assessment.
21E	E - Risk Analysis	Risk analysis is the process of identifying and analysing potential issues that could negatively impact key business initiatives or projects.
22E	E - Sustainability	Avoidance of the depletion of natural resources to maintain an ecological balance.
23E	E - Social Learning	The theory of the learning process and social behaviour proposes that new behaviours can be acquired by observing and imitating others.
24E	E - Collaboration	Collaboration is the process of two or more people, or organisations working together to complete a task or achieve a goal.
25F	F - Communication	Communication is the act of conveying meanings from one entity or group to another using mutually understood language.

Table 7: List of all 25 micro-credentials, including short descriptions for each competency.

This table has been developed by using Bloom's taxonomy alongside the 21st Century Skills Framework. The first 6 competencies cover subject-specific skills, strongly aligned with Bloom's taxonomy with A representing the lowest aspect of Knowledge and F representing the highest point within the hierarchy of Create. The general containers are derived from placing each of the 21st Century within Bloom's taxonomy hierarchy allowing for a simple hierarchy of skills to be produced. This process has culminated with the creation of 25 skill areas, 6 which are subject-specific and 19 which are transferable.

The containers are generic and are limited in number to ensure that such a system would be easy to learn and encompasses any skills which a student would gain throughout any educational journey and can be used as a simple method of evidencing their learning in a more granular way than subject qualifications or transcripts. In the future if new skills do arise, such as computer skills has done within the last 40-50 years, these could be quickly added to the table without it being lost within a framework of 100's of skill areas.

3.2.1 Subject-Specific Mapping

The focus of this research is not based upon subject-specific skills due to the complexity of any mapping as each subject is inherently different. Therefore, the subject-specific mapping will follow the same principles as the first iteration mapping with each learning outcome residing within one of the six subject-specific skill areas using the same keyword analysis and contextual cues.

One of the reasons for this would be to allow a university degree to be broken down into smaller parts and expressed as a combination of the 6 subject-specific skill areas. This would provide invaluable information about the course whether the course is knowledge recall-based, mainly comprising of 1A – Theory, or through completion of projects which would involve 1D – Process and Production more heavily than other skill areas. This information would useful for prospective students, course leaders and employers to transparently see projected skill distribution or individual students skills if they follow a non-regular program of study, such as taking modules from a different department or taking less popular modules that a department offers.

3.3.2 Transferable Skills Mapping

For this methodology, the transferable skills will have the most complex mapping as this project explores the possibility of using micro-credentialing for representing the transferable skills gained within a particular programme of study. However, this amount of detail cannot be obtained from subject-specific skills due to them being non-transferable across all subject areas, but this does not mean students have not learned transferrable alongside the subject-specific content.

To gather an understanding, module learning outcomes shall also be mapped to general skills. The difference with this mapping is that each learning outcome can be mapped to more than one skill area. This approach has been chosen as transferrable skills are not developed in independence and are likely more than one skill is being used, the example of writing a dissertation is likely to encompass most of the general skills

Transferable skills mapping will follow the same principles as the first iteration mapping with the main difference being that it is a one-to-many mapping, but still using keyword analysis and contextual cues to assign each learning outcome to skill containers. The method by which this will be done will be described in the following section.

3.3 Production of Hours per Skill Area

Now that the mapping has been completed for subject-specific and transferable skills, further calculations can be executed to give a breakdown of hours per skill area for a specific programme of study, and therefore showing the estimated hours in each trained skill area.

3.3.1 Subject-Specific Hours

A programme of study contains 360 credits, and it is expected that a student spends 10 hours per credit studying and developing their skills, this has been the standard for bachelor's degrees with honours within the UK. With subject-specific mapping being simple, the process at which the hours are determined is also relatively simple. Following this process:

Key information about each module needs to be gathered. The number of credits for a module. The number of learning outcomes for a module.

Therefore, hours for a module can be determined by:

$$Hours\ for\ a\ module = 10 \times module\ credits$$

Using the assumption that each learning outcome for a given assessment is equally important as the others, therefore they will have equal weighting. The number of hours per learning outcome for a given assessment can be determined using:

$$Number\ of\ hours\ per\ LO = \frac{Hours\ for\ the\ module}{Learning\ outcomes\ for\ the\ module} \times Assesment\ percentage$$

Using the subject-specific mapping it is possible to work out the number of learning outcomes in each skill container and therefore, the number of hours for each skill area.

By repeating the steps above for all the modules within a specific programme of study, develops a picture of which skills are developed throughout the years of studying.

3.3.2 Transferable Skills Hours

As the transferable skills mapping is one-to-many, it makes determining the number of hours per skill area a more complicated affair. By following the method below its possible to determine the number of hours for each skill container;

Key information about each module needs to be gathered. The number of credits for a module. The number of learning outcomes for a module.

Therefore, hours for a module can be determined by:

$$Hours\ for\ a\ module = 10 \times module\ credits$$

Hours per assessment is determined through;

$$Hours\ per\ assessment = Hours\ for\ the\ module \times assesment\ percentage$$

As this is a many-to-one mapping, each learning outcome is likely to be mapped to more than one skill area, the first step is to determine how many skill areas a singular learning outcome resides, this can be denoted;

$$LO_i = Number\ of\ skill\ areas\ the\ learning\ objective, i, resides$$

Where i denotes the learning outcomes listed within the module specification. Using the following calculation for the number of hours in each skill, z_i, where $1 \leq i \leq 25$ using Table 7 numerical referencing;

$$z_i = \frac{Hours\ for\ a\ module \times assesment\ percentage}{Number\ of\ learning\ outcomes \times LO_i}$$

Once the hours have been determined from the number of skills from each of the learning outcomes, it is possible to then determine the number of hours for each of the transferable skill. By repeating the above steps, it possible to determine the number of hours for each module within a specific programme of study, and this can be used to represent the estimated hours gained within each skill area.

3.4 Summary: Methodology

This chapter covers the theoretical approach, which is qualitative research, which is based upon secondary sources all derived from large institutions such as professional bodies, government bodies, and universities. The information and skill requirements have been codified into common themes based upon the 21st-century skill framework.

The first part of this methodology is to take QAA and professional body requirements to detail the minimum requirements set forth by QAA and the requirements expected at a professional standard within a particular discipline. The second part of this methodology is to take an institutions module specification to allow mappings to take place detailing the skills distribution for a course of study.

This allows for the application of the mapping solution into two different levels of granularity to gather a greater level of detail about an individual's particular skills and allow a cross reference for accuracy of results. This could further allow comparison between different institutions with the same degree course.

Chapter 4

Analysis

The previous section outlined a methodology for two different levels of granularity which could provide great insight into the distribution of skills for a given subject or specific university programme of study. The aim is to help students, employers, and universities gain a greater understanding of their course, students transferrable skill distribution, and improve transparency for employers looking for skills. This chapter applies the methodology to a multitude of disciplines to test transferability and applicability to these subject areas and then takes the results to affirm that this methodology can be used to present a transparent method to represent an individual's transferrable skills. This shall be conducted by analysing the different mappings produced.

4.1 Deciding on Subjects for Analysis

The subjects which have been chosen for analysis aim to encompass a wide range of different subject areas and potential skills differences within those skill areas. The subjects are;

- Computing
- Engineering
- Psychology
- Law
- Accountancy
- Marketing
- Languages

These subjects aim to cover the broadest range of subject areas which are taught at most universities in England, encompassing traditionally science-focused subjects to humanity-focused subjects while also including cross-disciplinary subjects such as psychology and marketing. All these subject areas have links with professional and accreditation bodies. The spread of accredited courses have also been chosen to see the suitability of such a framework which would have to compensate with varying reporting styles within the QAA and professional bodies for learning requirements.

The mapping process has been done to all the selected subject areas, and for the sake of the flow and understandability of this and later sections, this process shall be shown in full for an accredited Computing degree. For all subject areas, the data shall be included in the appendix and will be referred to throughout.

4.2 First Iteration of Mapping

4.2.1 Mapping of QAA Subject Benchmarks

The initial mapping was taken from the Quality Assurance Agency for Higher Education (QAA) for each of the different subject areas, and this gave the overall view which skills the QAA deem to be essential for these subject areas and allows for compassion between subject areas.

As for Computing, following QAA benchmark was taken to produce the number of learning requirements. The following learning outcomes are in Table 14 in the appendix and this shows that there are 18 learning requirements which can be mapped. After the mapping process, the following figure can be produced;

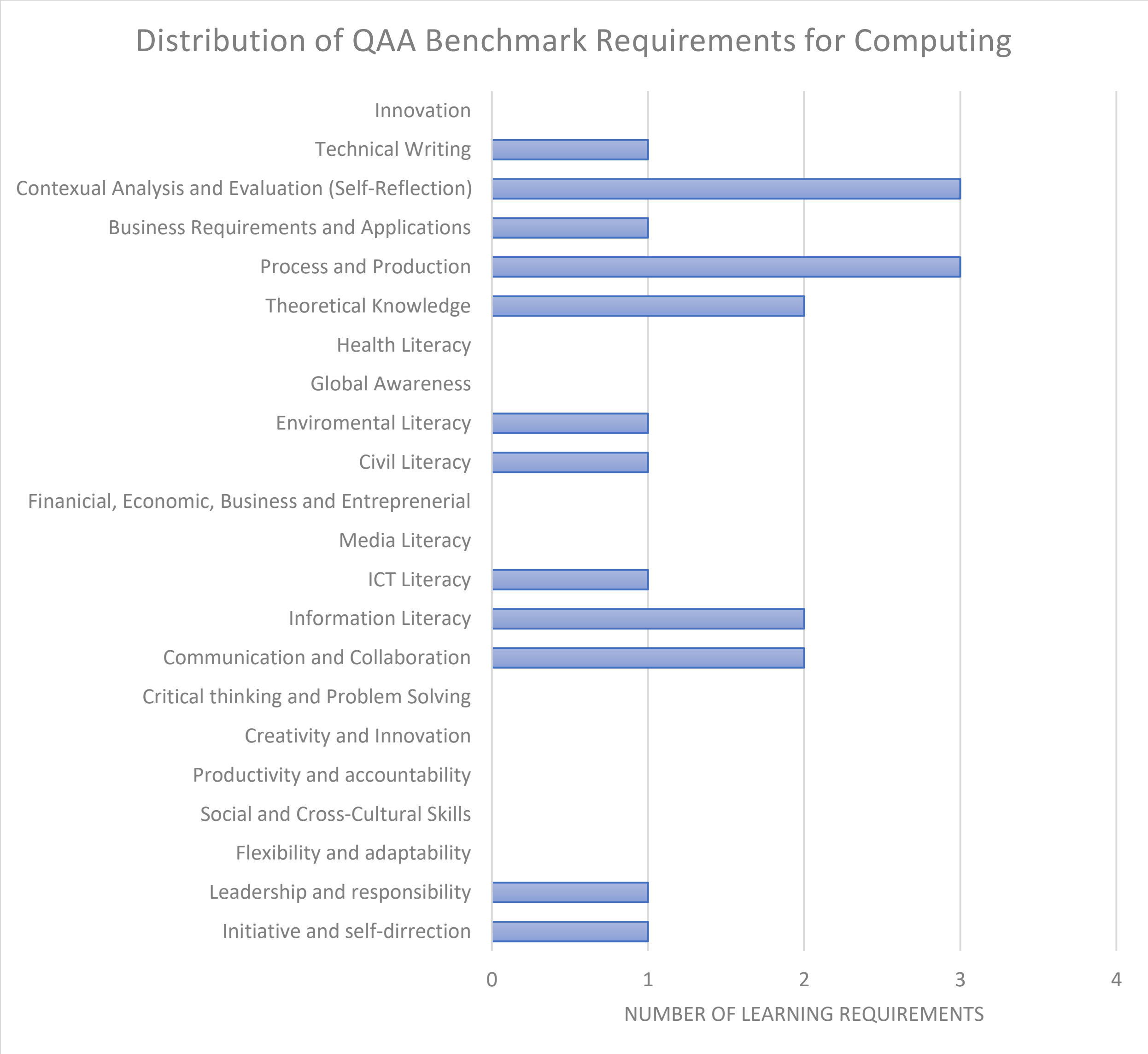

Figure 7: Figure displaying the distribution of the QAA benchmarks learning requirements to each skill area for Computing.

This graph shows that the QAA places particular focus upon subject-specific skills with less than 45% of learning outcomes being within a transferable skills category. This also shows a particular lack within some skill areas with a multitude of gaps within the figure above. There is lack of learning towards Financial, Economic, Business and Entrepreneurial, Global Literacy and Health Literacy displaying that the required learning put forward by the QAA are being neglected for the sake of more subject specific skills, therefore it can be argued that these students will not have the breadth of knowledge employers would assume.

Graphs for the other subject areas can be found in appendix C. All these figures (Figure 7, Figure 26 - Figure 31) show that each of the different committees which look over each subject area within the QAA have different aims in mind for their subject. A lack of uniformity in the number of learning outcomes in the benchmarks with some subjects having few or limited criteria, while others have a more comprehensive list. The distribution across skills can be very different when comparing subjects with some QAA reports focusing on a particular skill set more than other subject benchmarks.

Engineering was the only subject which did not have any QAA benchmark learning requirements but referred them to the UK standard for professional engineering competence (SPEC), which is a standard that complies with the Washington Accord for engineering (Alliance, 25 Years Washington Accord, 2014).

The QAA Benchmarks allow for a very elementary indication on how a particular course develops skills and by what amount they are developed, even with the limited information that the QAA Benchmarks provide. It is worth noting that it does not give a true reflection of a particular course as these are a very loose set of learning requirements and still allow for diversification in course specification between universities. Therefore, this allows universities to develop skills which are not explicitly stated in the QAA benchmarks to differentiate or stand out from other similar institutions. This topic has been explored in the literature review.

The elementary indications are that there is no standard within the QAA benchmarks and that the learning requirements are broad and encompassing many aspects of a course a students would be need to engage with throughout. At this point with the QAA benchmarks being a requirement for an honours course, it does not indicate that those requirements are 'subpar'. Another point of note is the overall lack, across all benchmarks, of 21st-century theme skills.

4.2.2 Mapping of Professional Bodies Benchmarks

As stated above, the QAA benchmarks are limited in approach and are used to ensure that university courses are meeting the required minimum standard for their courses. Many universities take their standards much further and use professional accreditation bodies to accredit their courses. Then, additional mapping of the appropriate accreditation requirements allows for a full comparison between requirements for the QAA and the professional bodies to explore the possibility of a mismatch between the two accreditation bodies. By doing it this way, it allows for the exploration of the similarities of each different subject area alongside their fundamental differences.

Taking the BCS guidelines on course accreditation and the amount of detail within their documents allowed for the development of learning outcomes for different accreditation levels. These include bachelor's degrees (BSc), masters degrees (MSc), Chartered IT Professional (CITP), Chartered Engineer (CEng) and Incorporated Engineer (IEng). By far, Computing is the subject area which contained the most varied number of accreditations learning requirements depending on the level of accreditation, with Engineering coming in second; with Engineering learning outcomes covering Engineering Technician (EngTech), Chartered Engineer (CEng) and Incorporated Engineer (IEng).

Many different accreditation levels between Computing and Engineering can be attributed to the accords for each of the subject areas, with much more research and time dedicated to making comparable levels across multiple different types of higher education systems across the globe. Looking at a graph of each of the different learning requirements for each of the different accreditation levels, gives a more visual and precise representation of skill areas which are proactively pursued by the BCS.

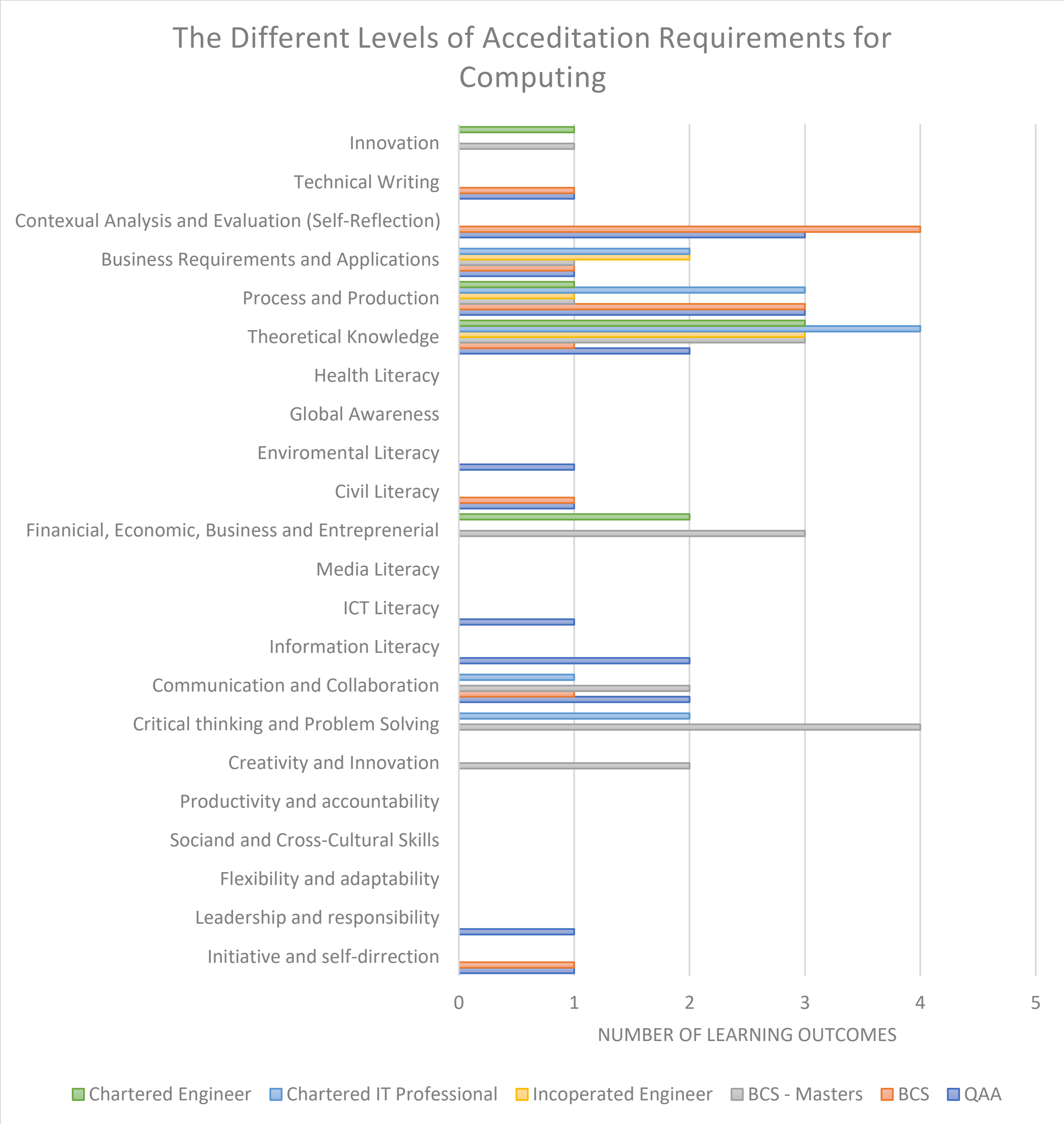

Figure 8: Graph displaying the different learning outcomes for each of the different accreditations for computing, gathered from the BCS. BCS category in the above table refers to general undergraduate requirements for BSc courses.

However, it clearly shows that all learning requirements are focused on subject-specific knowledge and learning innovation skills, with the sparse addition of requirements in the other areas with little uniformity between the different levels of accreditation. As these are professional body requirements it would be expected that most of their learning requirements would cover subject specific skills. There are the same gaps with no learning requirements to that displayed in Figure 7 which maps the QAA requirements, showing that the professional body requirements for computing are very much built upon the requirement put forth by the QAA.

For the different levels of accreditation of courses shows there is little deviation within the skill areas a learning requirement resides, but this does not consider the complexity of difficulty of the learning requirement. This clearly displays the areas which this accreditation programme is lacking such as Health Literacy, Social and Cross-Cultural Skills and Productivity and Accountability which are very important skill areas which businesses look for in graduates to see if they would make an effective employee.

At this point, only the number of learning requirements have been mapped. This does not provide an accurate image of how each learning requirement is spread across each of the different levels of accreditation. It can be assumed that there is a hierarchy which accreditation follows with the expectation of completing all requirements throughout each of the different levels. This can be seen in the following flow diagram.

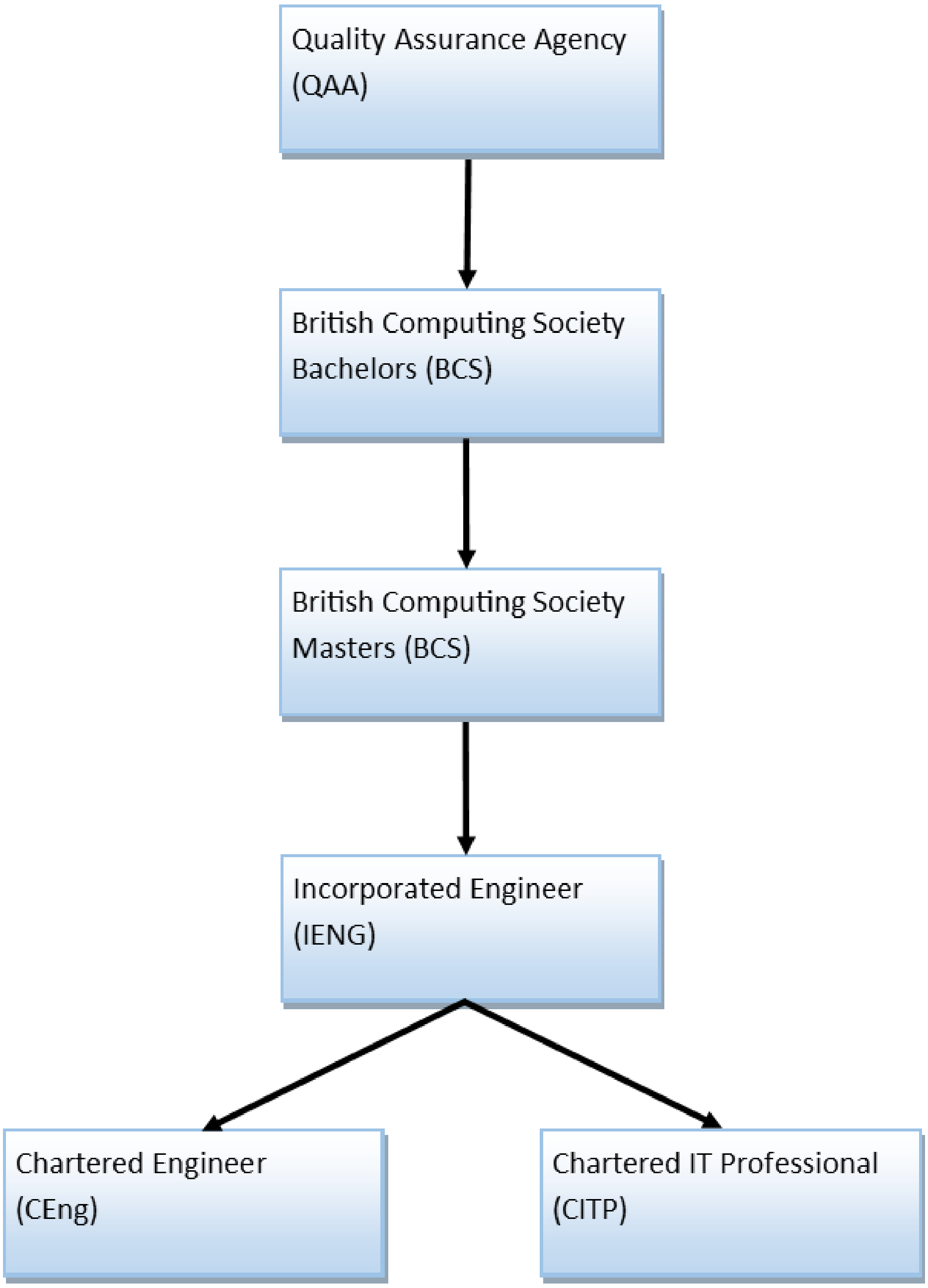

Figure 9: Diagram displaying the assumed way in which learning outcomes can be tiered and require previous learning requirements.

By taking the prerequisite approach, does allow for the creation of an additional graph, which can illustrate a clearer picture of learning requirements for each of the accreditation levels when considering the prerequisite requirements. This approach likely, not perfect as a student could study an associated degree and then post-graduate courses accredited by the BCS, it can still provide additional information about the hierarchy of skills and display that both Chartered Engineer and Chartered IT Professional would be expected to have met and exceeded the requirements lower down the hierarchy.

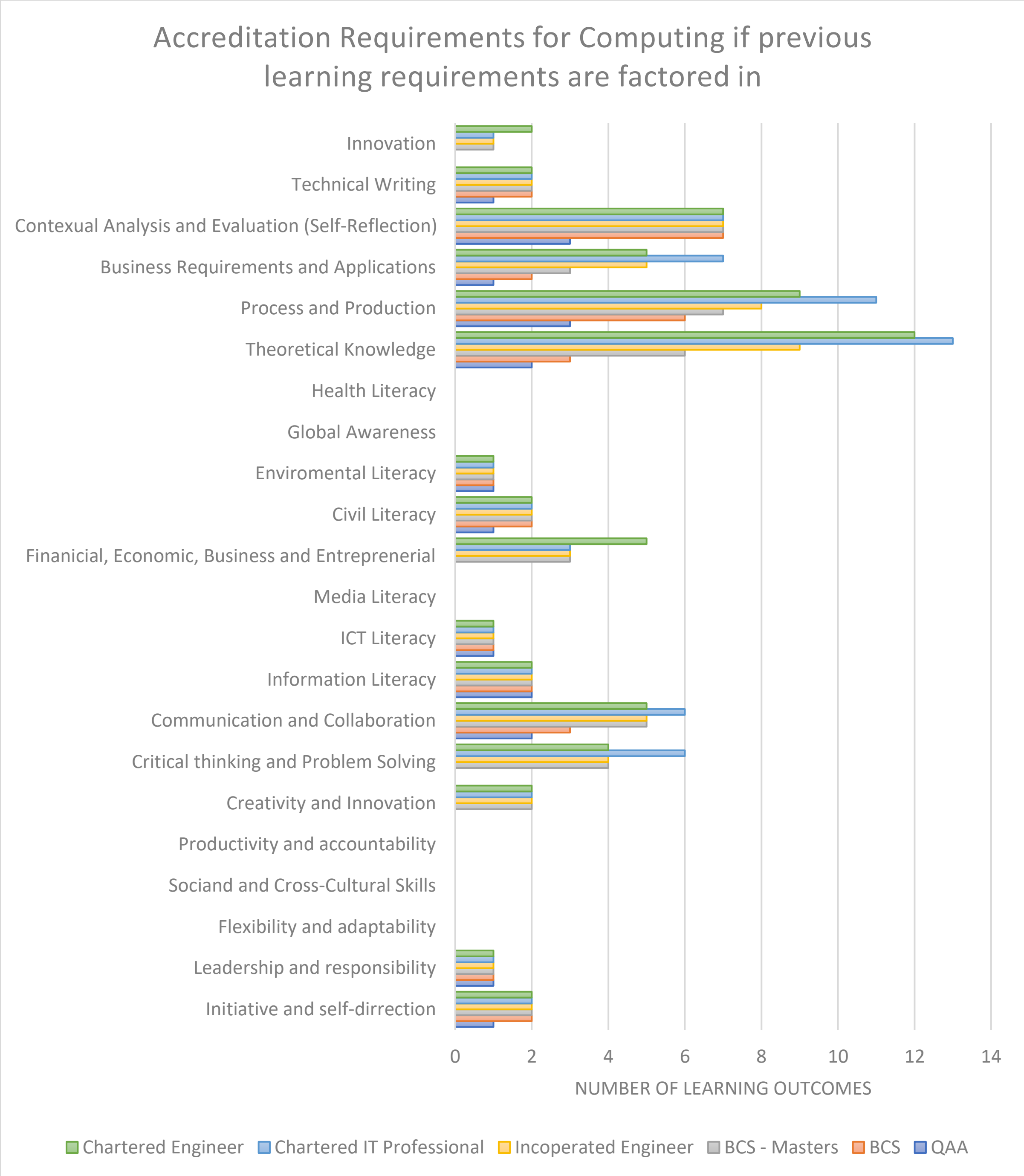

Figure 10: Graph displaying the learning outcomes for computing if the previous accreditation is factored in.

With the combination of Figure 9 and Figure 10, it can be seen that all the accreditation levels have roughly the same expected set of skill requirements, mainly focusing upon subject-specific knowledge, even if that seems at the detriment of other more ‘soft skills such as Social and Cross-Cultural Skills and Productivity and Accountability. The lack of skill in these areas further supports the claims made within the previous section; that this could point toward the prolonged lack of change of requirements and that the skills which are being developed are not sought after by employers. Given that these professional body requirements do not spread well across all categories which are deemed to be important, this shows a gap within the current accreditation scheme for the BCS as some essential skills seem to have been neglected. This could suggest that a degree program accredited by a professional body does not develop skills which employers would seek, such as Flexibility and Adaptability or Media Literacy.

Furthermore, taking the mapping for Languages and comparing the results to that of Computing, Languages are lacking the detail in their learning outcomes to effectively conduct the mapping process, with many of them overlapping and therefore causing significant peaks compared to other skill areas therefore potentially neglecting many other skill areas. The case for Languages is not helped by the lack of professional body guidelines. The disparity between the two subjects is enormous in terms of granularity of learning outcomes and the overall maturity of the respective professional bodies. This indicates that the QAA and the professional bodies have much more work to do to give a more comparable list of learning outcomes across different disciplines.

As for other subjects such as Psychology and Marketing, they have produced results for both the QAA and their respective professional bodies showing that they do aim to cover many different skill areas from career and life skills to subject-specific. The overall impression that these graphs give is that the QAA and professional bodies have different aims for their learning outcomes. Many of the learning outcomes provided by the respective professional bodies are focused upon the subject itself, which for professional bodies is expected. For the QAA where universities aim to develop well-rounded students, with subject-specific knowledge, many of the transferable skills are very much lacking. This is a slight indication that the QAA benchmarks need to be revised to cover more of the transferable skills or place more emphasis within the context of the subject-specific skills to provide graduating students with a better chance of being successful within their career.

4.3 Second Iteration Mapping

To ensure that the first iteration of mapping or a mapping that has been produced on the national programme level is relatively accurate, a more granular mapping based upon module specifications can be used as a comparison. This mapping is much more involved and for a given programme of study can have a multitude of different modules to make up the complete degree. For this purpose, the mapping has been produced on the following modules at the institution studied;

	Module Code	*Module Name*	*Module Credits*	*Learning Outcomes*
Year One	CFS2160	Software Design and Development	40	8
	CFM2175	Computing Science and Mathematics	20	12
	CFS2143	Hardware and Networks	20	9
	CFT2112	Studio 1	20	6
	CFP2125	Project 1	20	6
Year Two	CIS2344	Algorithms, Processes and Data	20	8
	CII2350	Team Project	20	8
	CIS2360	Relational Databases and Web	20	10
	CIS2201	**Cyber Security**	20	10
	CIS2380	**Operating Systems and Language Translators**	20	8
	CIM2130	Computational Mathematics	20	10
Year Three	CSP2010	Personal Social and Technical Skills	60	3
	CSP2020	Self-Assessment Skills	60	7
Year Four	CHP2524	Individual Project	40	7
	CHS2546	Distributed and Client-Server Systems	20	7
	CHA2555	Artificial Intelligence	20	8
	CHM2130	**Computational Mathematics 2**	**20**	**7**
	CHS2402	Large-Scale Software Engineering	20	5

Table 8: The selection of modules chosen for the second iteration mapping.

This list of modules makes up a three-year Computer Science degree with a year in industry. The list of modules is comprised of core modules for Computing, Computer Science, and Software Engineering, giving the most generic module selection which could allow a student to progress into several different fields. The completely optional modules have been highlighted in bold in Table 8 and this is 60 credits out of 360 credits of a degree program. The analysis below is based upon a singular degree path and not the full programme that an institution could provide. The same analysis can be done for each module and a tool for combining the modules could be produced to provide information for specific module choices.

4.3.1 Subject-Specific Mapping

By mapping all the learning outcomes to the respective six subject-specific outcomes and then to the corresponding assessments, it gives the following information distribution for each of the four years. The labels provided (A through to F) refers to Bloom's Taxonomy with A being the lowest in the hierarchy (Knowledge) and F being the highest (Create). A point of note is that year three within this section refers to a sandwich year which would mean students would be on industrial placement and undertaking two placement modules, around improving transferable skills.

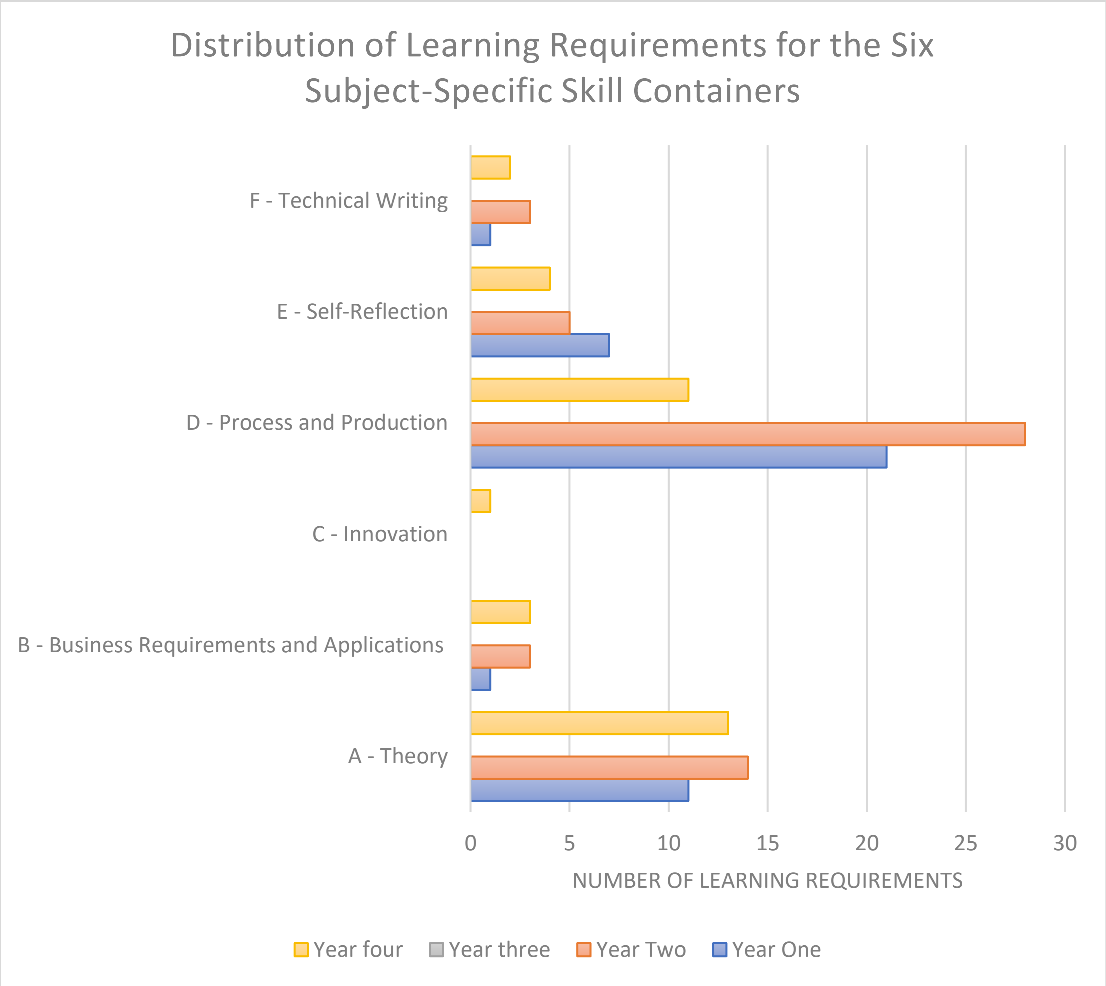

Figure 11: Graph displaying the distribution of learning outcomes for the six subject-specific skill areas.

From the graph above, it is possible to gather an elementary insight into the subject-specific. Currently, for this program of study, roughly equal emphasis is being placed in A – Theory, the same could be said for B – Business Requirements and Applications, and F – Technical Writing. This level approach is expected for a balanced curriculum.

A specific point of note is the decreasing number of learning outcomes for E – Self-Reflection, over the course of the four years. This suggests that more emphasis is placed upon developing reflection skills early on during the course so those skills can be used throughout the remainder of the course even if the skill is not listed as a requirement. Another is the emphasis upon D – Process and Production, which is considerably higher than any other skill area. This shows that this programme of study placed significant focus upon being able to apply the subject-specific knowledge and skill learned throughout the course.

The above conclusions are elementary as they only show results for the learning requirements for each year. This does not take into consideration the number of credits per module, percentage weighting of assessment for a given learning outcome, or the variation in the number of outcomes per year. To illustrate how Figure 11 could potentially give a false impression, the figure below shows the distribution of learning outcomes for each year of the programme;

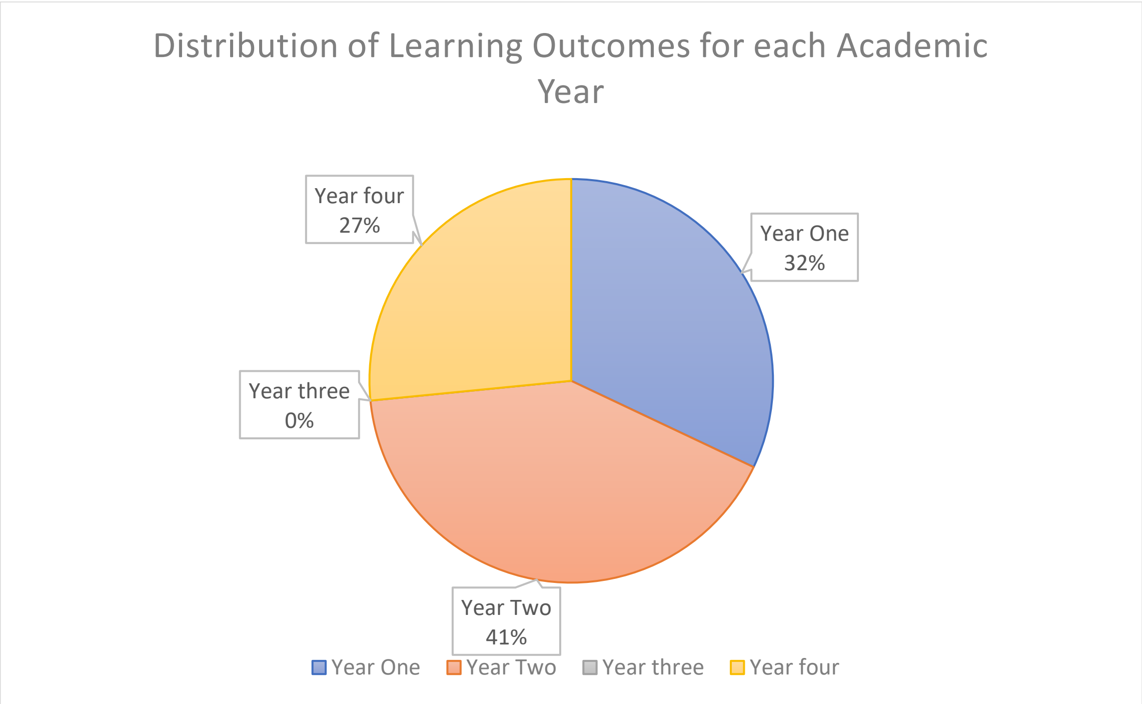

Figure 12: Pie chart showing the distribution of learning outcomes for each academic year.

The figure above makes it evident that considering the number of learning requirements per year could provide a false representation. As year two has the most learning requirements, it suggests that each learning outcome would have less time spent on it, therefore developing that skill for less time. When taking into consideration factors such as the number of learning requirements per year, module credits and assessment; it produces a different graph which much more accurately represents the expected time spent developing each skill area across each year of the programme;

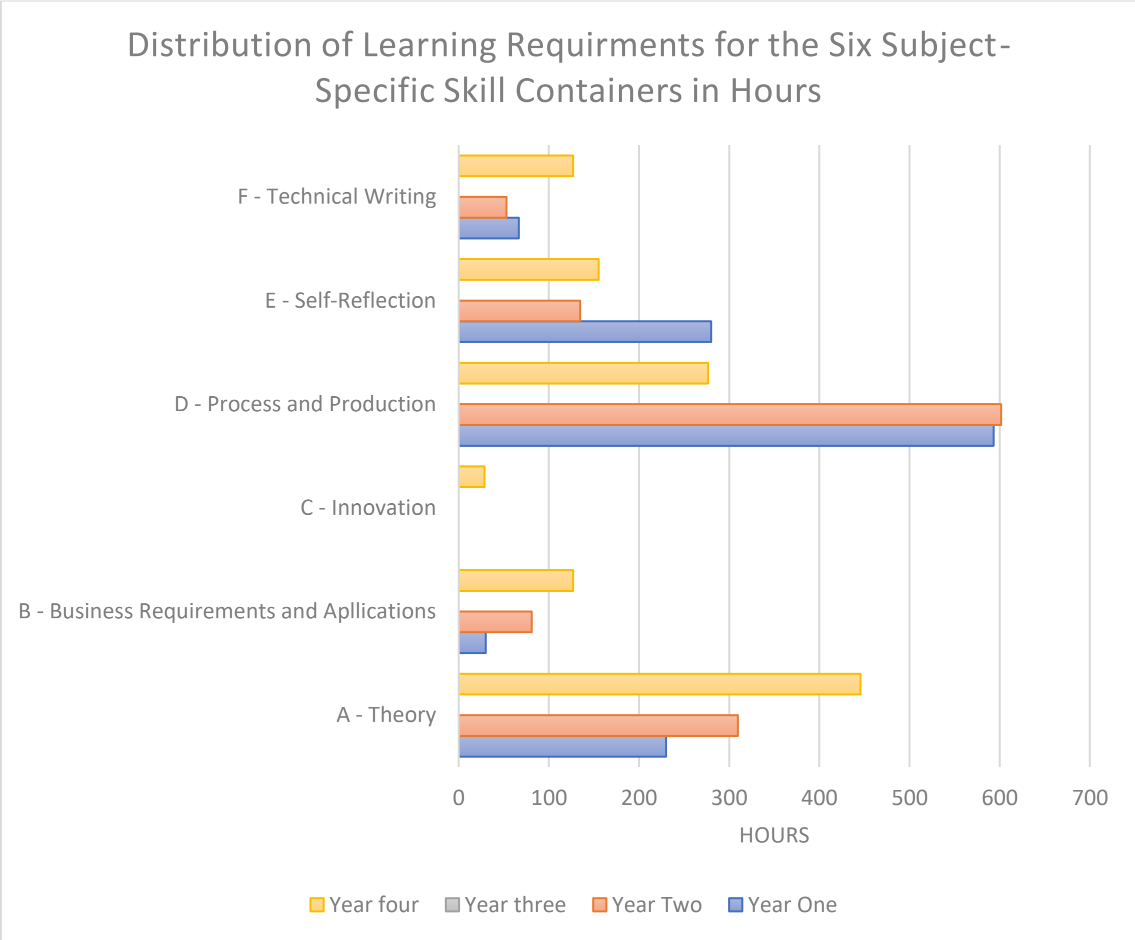

Figure 13: Graph displaying the distribution of learning outcomes for the six subject-specific skill containers when taking into consideration module credits, assessment weighting and the difference in learning outcomes between years.

This paints an entirely different image than that of just the learning outcomes, but the same overall observations still hold true, but with slight differences. Theory and Business requirements increase in the number of hours expected throughout the programme, this supports the thinking that a university degree prepares a student for the job market. Another interesting area is Technical Writing, showing that it is a skill that is being developed in conjunction with the other skill areas, but it lacks consistency throughout the years and could be a potential area of refinement to adequately prepare students for dissertation projects. The figure also shows a complete lack of innovative thinking, with it only being a learning outcome when it comes to the final year dissertation project.

The insights which can be gained at this level are very limited as they rely upon the accurate reporting of learning outcomes with the module specification. In this case, some learning outcomes could have resided within multiple different skill areas. The limited approach is of no real concern as this mapping solution aims to get a good approximation to the real skill developed during a student's studies and inform potential improvements to this mapping process.

4.3.2 Transferable Skills Mapping

This section aims to cover all the results gained from the one-to-many mapping described in the methodology. This section also aims to provide much more information about the transferable skills due to the many concerns brought up in the literature review. The initial step is to display the number of learning outcomes in each transferable skill container per module; the full break down is displayed in Table 17.

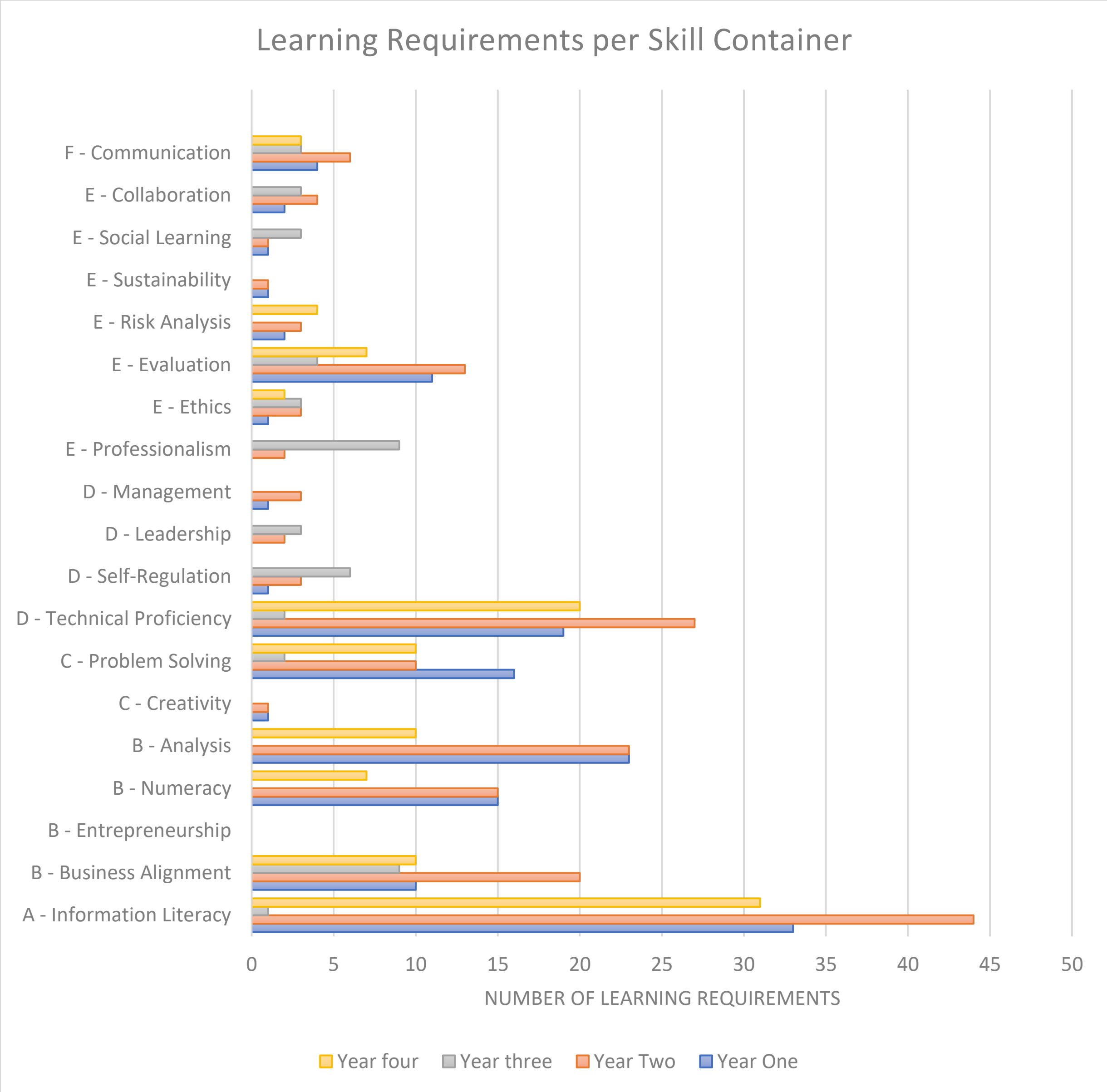

Figure 14: Graph displaying the number of mapped learning outcomes to each transferrable skill container.

The above figure is very telling, showing that emphasis within many learning outcomes is placed upon Information Literacy, Technical Proficiency, and Analysis. This is somewhat expected from a Computer Science degree as it is a very technical degree, but like all the previous mapping, it shows an apparent lack of focus upon 21st-century skill themes, which has already been outlined within the mapping of the QAA benchmarks. The above graph contains a considerable number of containers. Condensing the above figure into each of their respective skill areas produces the following;

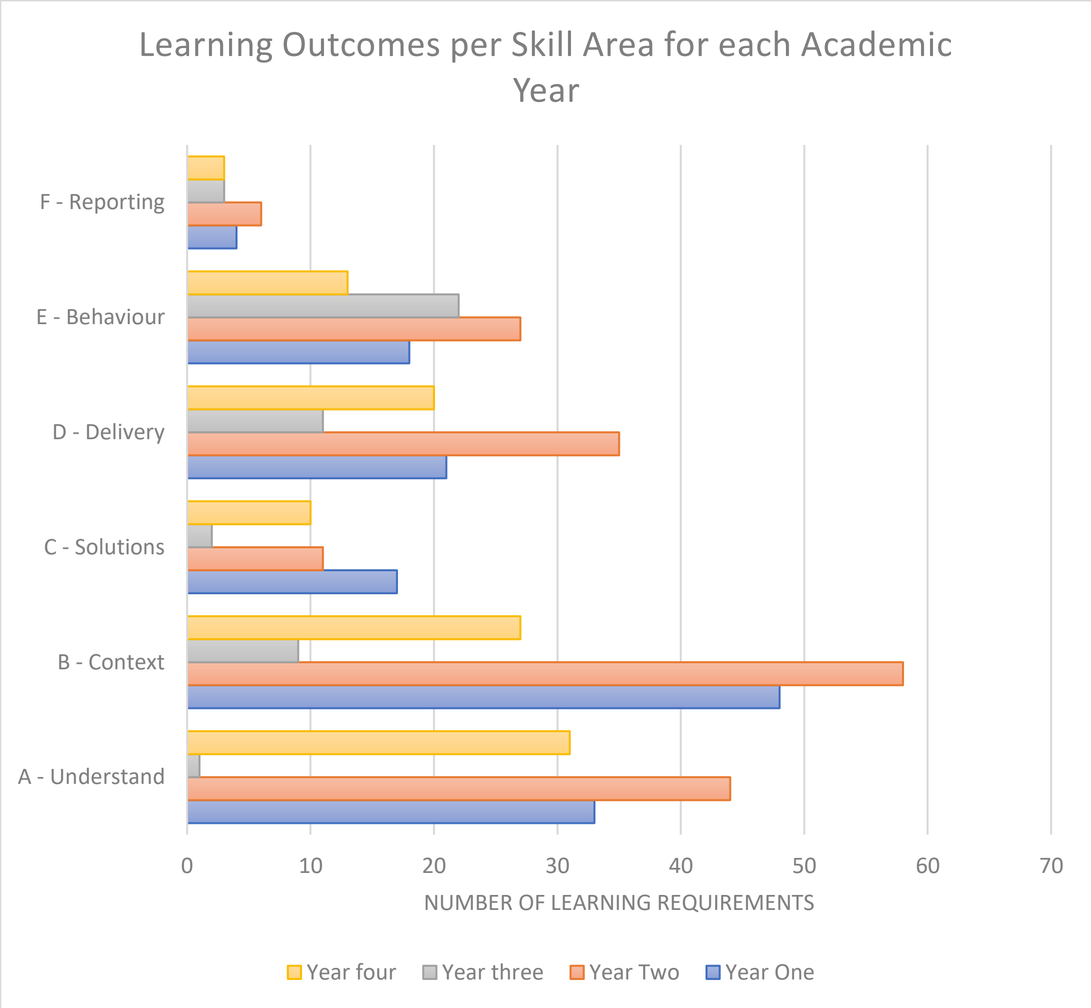

Figure 15: Graph displaying the number of mapped learning outcomes to each transferrable skill area.

By doing this grouping, the distribution loosely follows Bloom's taxonomy triangle, Figure 4, of categories of skills. Similarly, within the previous section, only displaying the mapping of the learning outcomes does not produce an accurate enough description of the skill gained. With both Figure 14 and Figure 15 suffering from this inaccuracy, it has already been established in Figure 12 that the learning outcomes within each year of the programme are not equal. This is exacerbated after conducting the one-to-many mapping which is required in this section. The distribution after the mapping is as follow;

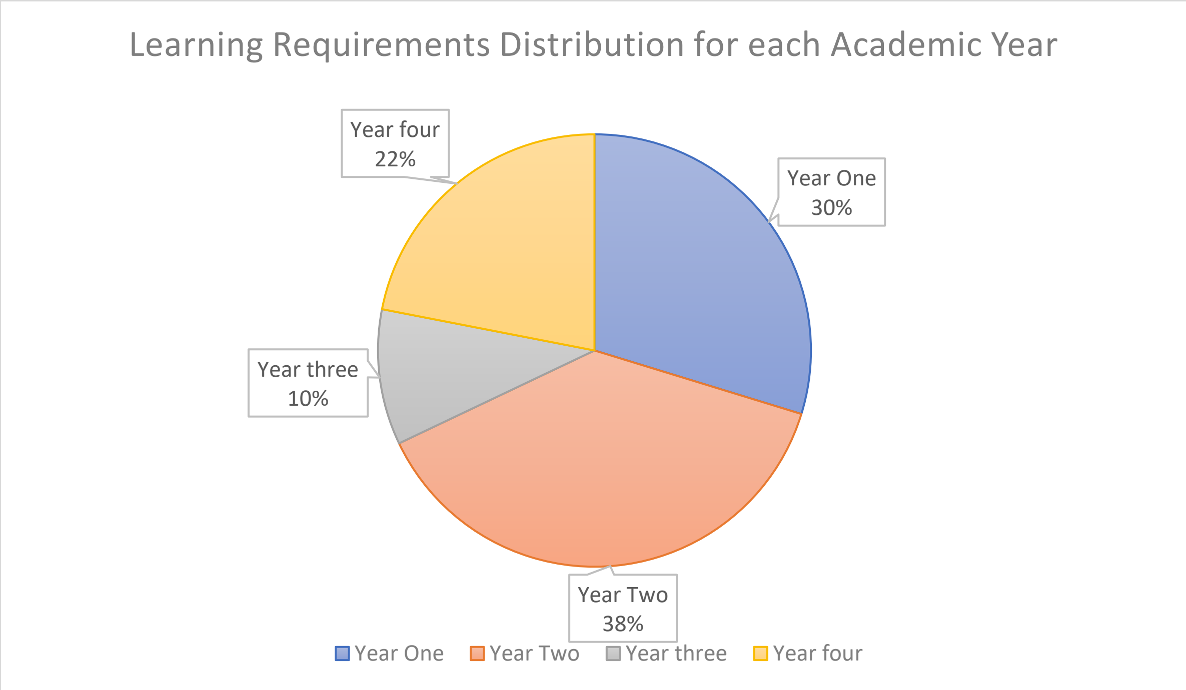

Figure 16: Pie chart displaying the distribution of learning outcomes after conducting the one-to-many mapping for the transferable skills.

The pie chart makes it evident that without taking into account other factors such as module credits, assessment weighting for learning outcomes, and the difference in the number of learning requirements per module, it would be impossible to have a useable model to analyse. It can be seen here that Year three has gone from a 0% share of learning requirements within the subject-specific mapping to taking a 10% share, this is to be expected due to it being a sandwich year and focusing on transferrable skills gained by working with an industrial partner. By considering these issues, it allows for the production of more accurate results from which many more accurate conclusions may be taken. The adjusted graph takes each credit to be worth 10 hours of work as the constant used throughout the program;

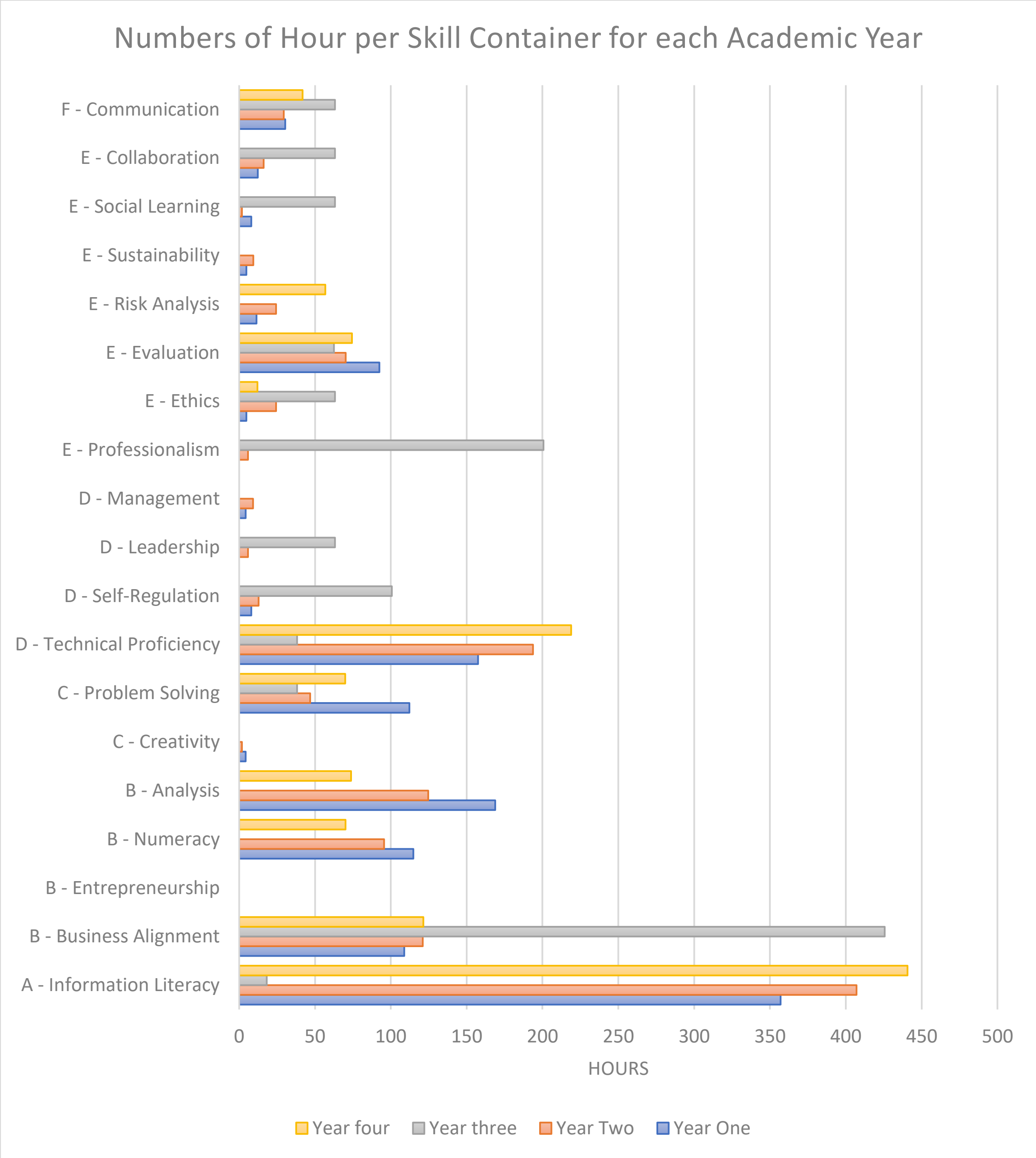

Figure 17: Graph displaying the number of hours in each skill area when considering module credits, learning outcomes per module and assessment type.

Considering all the potential issues and setting a constant of 120 credits per academic year, allows for a more in-depth look into the emphasis that is placed upon some learning outcomes, skill areas, and skill development through the programme. The only area which has no time provided to it would be Entrepreneurship which is a critical skill if a student has the aim of opening their own business, in this specification, it would be expected that a student would learn this specific skill as an extra-curricular. Differences are already apparent between Figure 17 and Figure 14; shows that for both Information Literacy, the expected number of hours developing this skill increases. The same can be said about Technical Proficiency. This table is useful to display the potential of any programme as it offers a much more detailed insight into the aims and potential skill the programme aims to develop. Grouping the skill containers into skill areas produces the following graph which is much easier to interpret;

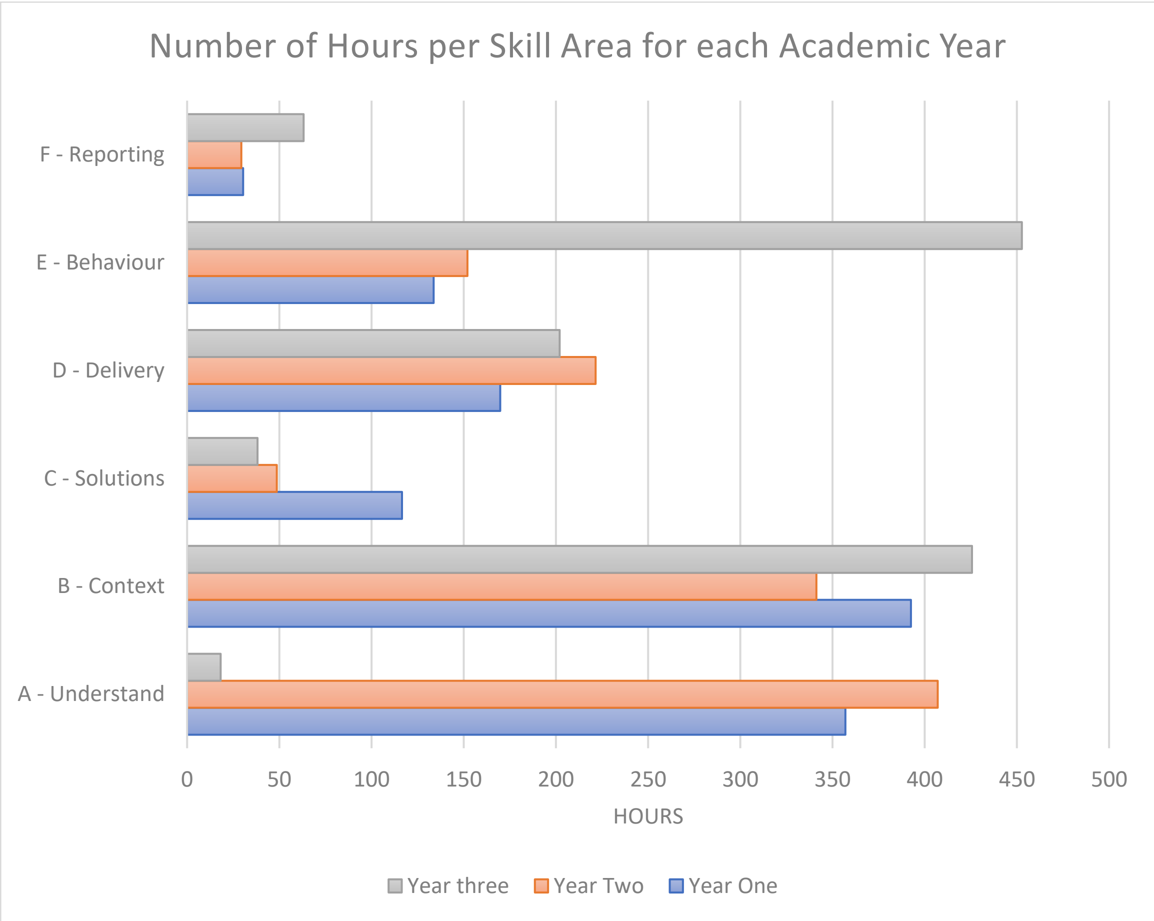

Figure 18: Graph displaying the number of mapped learning outcomes to each transferrable skill area based upon hours per learning outcome.

Year four is missing due to it being a placement year in which a student is gaining work experience with no academic learning taking place. Furthermore, this shows that areas such as Theory, Context, and Implementation are stable across all the years and maintaining high levels, showing that these skills are of importance within this programme specification. This comes at the cost of Innovative and Creative skills which have considerably slower levels than all the other skill areas. The breakdown of each of the six skill themes can be seen clearly within the following pie chart;

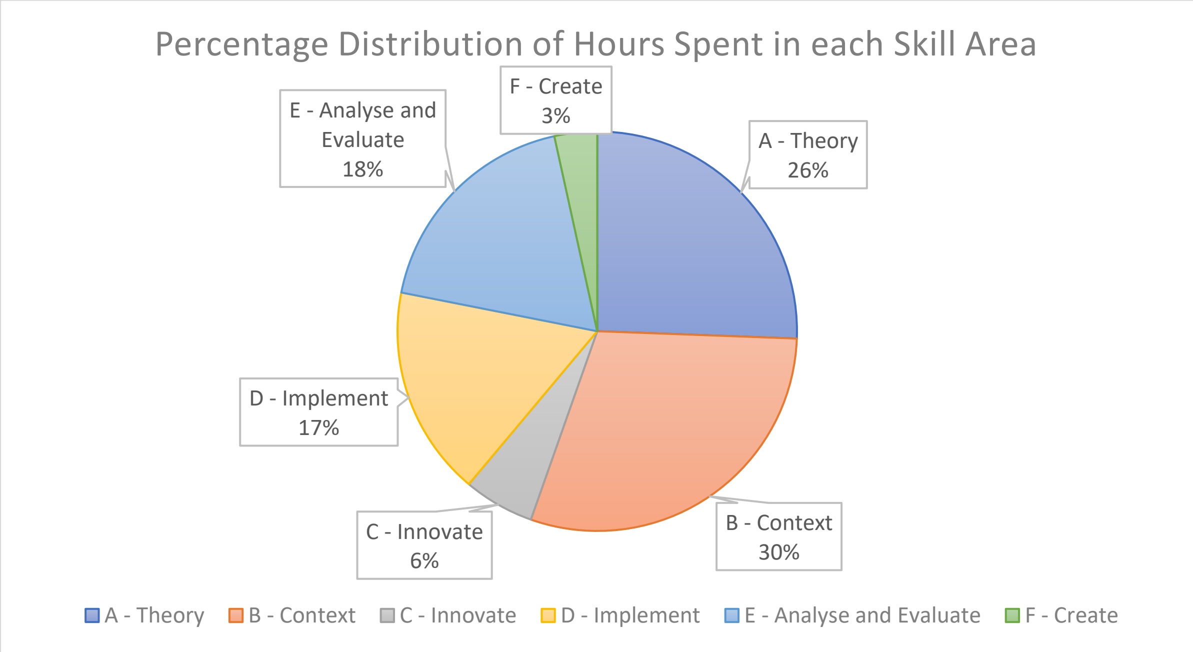

Figure 19: Pie chart displaying the percentage distribution of the number of hours spent in each skill area throughout the programme.

Implement skill area, this is not representative of all the skills within this area, as when compared to Figure 17 almost all the skill areas is comprised of mainly Problem Solving and Technical Proficiency skills. It is showing each of the skill areas with percentage values with each of the six skill themes (A – Theory and F – Create do not need their own pie charts as they do not have more than one sub-skill within their respective containers). The table below outlines all the percentage distribution for each skill within each of the six skill themes;

	Percentage		Percentage		Percentage		Percentage		Percentage
A - Information Literacy	100	B - Business Alignment	54	C - Creativity	2	D - Technical Proficiency	75	E - Professionalism	23
		B - Entrepreneurship	0	C - Problem Solving	98	D - Self-Regulation	15	E - Ethics	12
		B - Numeracy	20			D - Leadership	8	E - Evaluation	35
		B - Analysis	26			D - Management	2	E - Risk Analysis	10
								E - Sustainability	2
								E - Social Learning	8
								E - Collaboration	10

Table 9: Table displaying all the percentage distribution for each skill in each of the six skill themes.

The above table can take some time to understand, and by using pie charts it shows for each of the skill areas with percentage values with each of the six skill themes (A – Theory and F – Create do not need their own pie chart as they do not have more than one sub-skill within their respective containers);

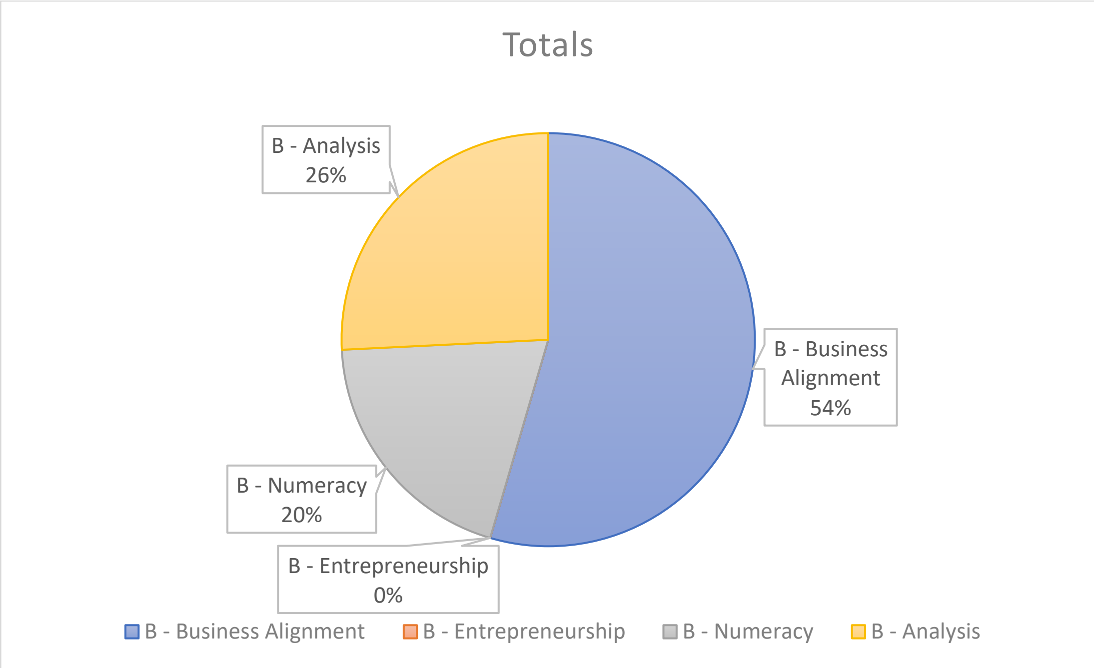

Figure 20: Pie chart displaying the distribution of hours in B - Context to allow for a better understanding of skill distribution.

Within this category shows that over 50% of the time is spent upon business alignment. There is not an equal weighting of these skills across this category with analysis and numeracy being within 6% percentage points showing they thought of as important as the other. The main point of concern is the total lack of entrepreneurship which does not even feature within this skills category. Using such figures can help course leaders fully understand their programmes of study and provide adjustments depending on their ambitions for the course.

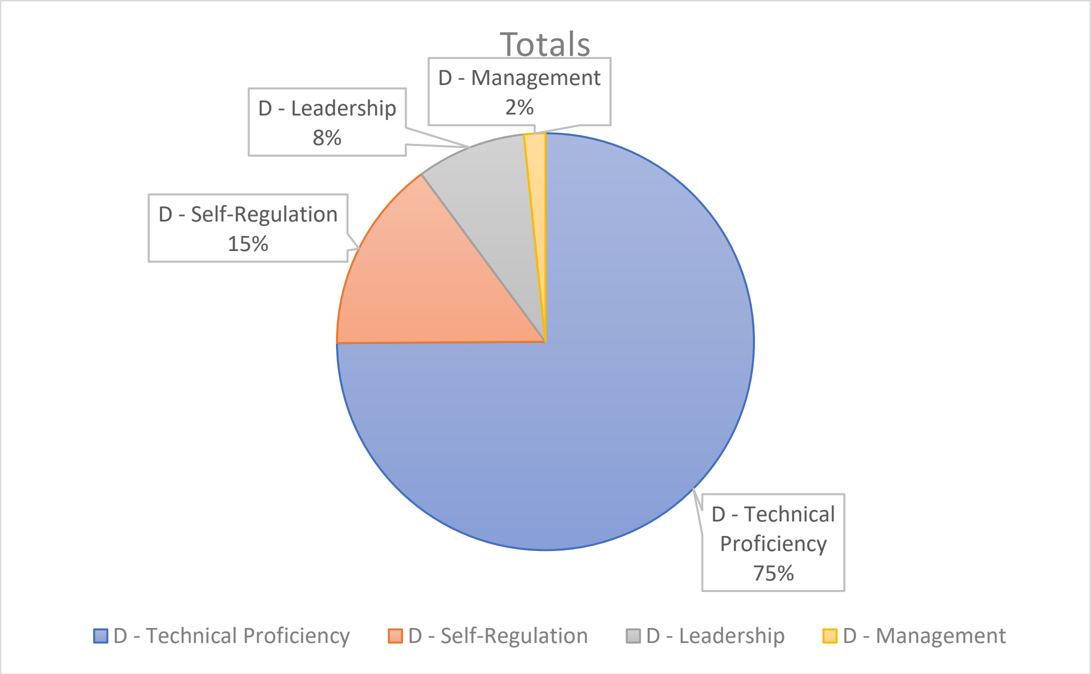

Figure 21: Pie chart displaying the distribution of hours in D - Implement to allow for a better understanding of skill distribution.

This category is heavily comprised of technical proficiency which makes up 75% of the total time within this category, this would be to no surprise for this course with the emphasis upon being able to apply knowledge to relevant problems. For computing, it would be expected that time spent on leadership and management would be reduced in this category, but it would probably not be expected to be as low as it have been found to be. It shows students on this course would be able to apply their knowledge but are likely to not have the leadership skills to lead a team project or task.

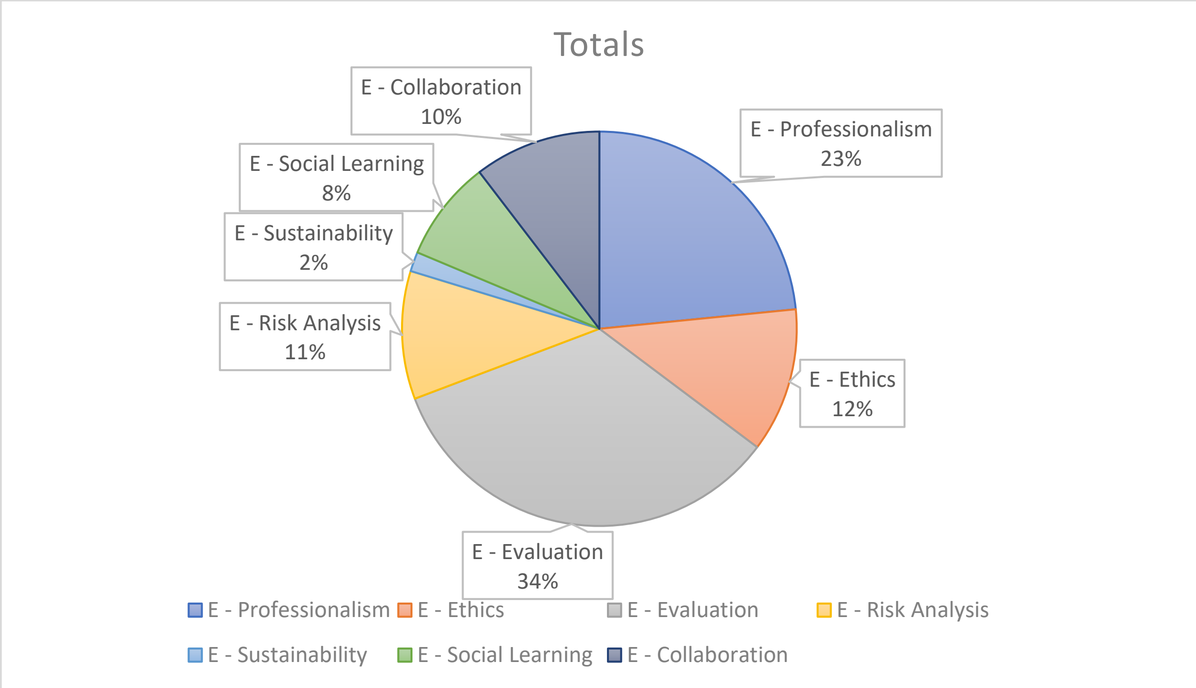

Figure 22: Pie chart displaying the distribution of hours in E - Analysis and Evaluate to allow for a better understanding of skill distribution.

All the above pie charts display the distribution between skills within a given skill area; this makes for the understanding of skill distribution. This shows that some skills have not been given an adequate level of attention. shows that all the Innovative skills are almost solely Problem Solving and hardly any time is given to developing Creativity. Additionally, Figure 21 shows a very uneven distribution with a little amount of time dedicated to Management and Leadership skills, both of which are sought after by employers. The most equal distribution with the least amount of variance in the amount of time spent on each skill component is shown in Figure 22, with the least amount of time spent on sustainability.

The graphics here allow for the gathering of much greater insight than anything that could be gained through a traditional transcript and provide a granular approach. This also allows for a better understanding of one's own potential skill set and find areas that could require improvement to make a balanced set of skills.

4.3.3 Comparison between First and Second Iteration Mapping

Comparing the two iterative mapping solutions should allow for the justification of the second iteration mapping, showing that the potential skills gained are still in line with the requirements set forth by the professional bodies. Additional, it should help show that courses provide additional skills in areas not required by professional bodies. The first approach is to compare the distribution of learning requirements for subject-specific skills between the two iterative methods;

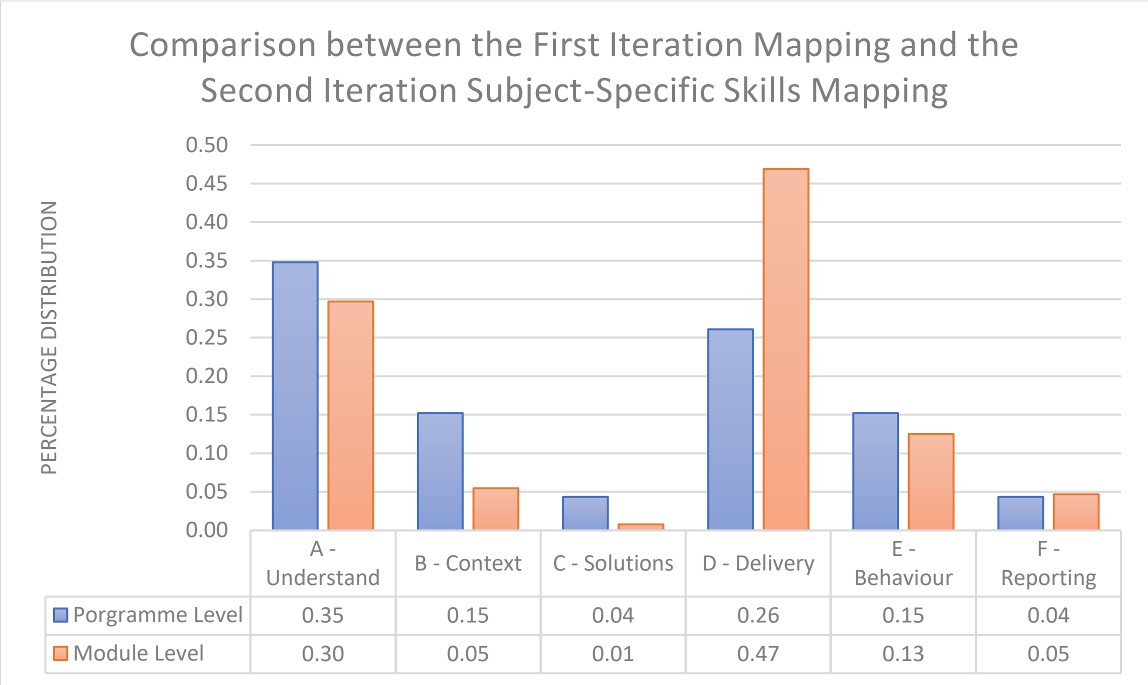

Figure 23: Graph displaying the percentage distribution of subject-specific learning outcomes for both types of mapping.

Figure 23, it shows the distribution from both iterations of mapping produce mappings which hold similar characteristics such as estimating the time expected to be spent on each skill, baring the differences seen in Delivery and Context which provide a 55% and 300% difference to each other respectively. This difference does not mean that this specific programme specification does not follow the professional requirements but instead suggests that it add additional requirements within this programme specification and therefore changes the overall weighting within the programme of study. This argument is further supported by the vast difference between the number of learning outcomes mappable between the two iterations of mapping, showing that individual programs have a much more granular approach to learning requirements;

	First Iteration	*Percentage*	*Second Iteration*	*Percentage*
Theoretical Knowledge	16	35%	38	30%
Business Requirements and Applications	7	15%	7	5%
Innovation	2	5%	1	1%
Process and Production	12	26%	60	47%
Contextual Analysis and Evaluation (Self-Reflection)	7	15%	16	13%
Technical Writing	2	4%	6	5%
Totals	46	100%	128	100%

Table 10: Number of learning outcomes used within each iteration of mapping.

Given the significant disparity in the number of mappable learning outcomes can help explain the variation when dealing with subject-specific mappings. Comparing the subject-specific mapping to that of the transferrable skills mapping also provides another interesting comparison which can further support the idea that both mapping approaches still display useable infomation;

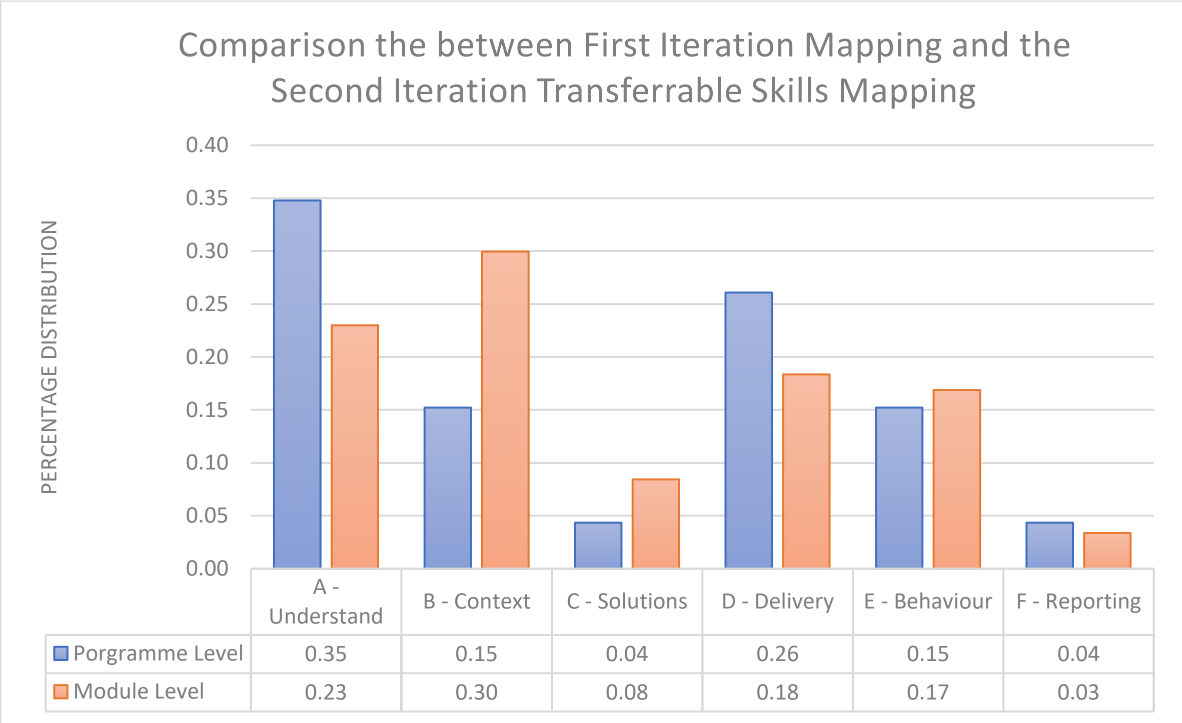

Figure 24: Percentage distribution of learning outcomes between the subject-specific mapping from the first iteration and transferrable skills from the section iteration mapping.

This figure shows much more variation than the figure, but still displays that both mapping iterations are usable and provide useful information. The increase in variation can be explained as the transferrable skill mapping is a one-to-many mapping and therefore has a considerable amount of learning outcomes which could rest within multiple of the different skill containers. The following table shows the variation in the number of learning outcomes between the two mapping solutions;

	First Iteration	*Percentage*	*Second Iteration*	*Percentage*
Theoretical Knowledge	16	35%	109	23%
Business Requirements and Applications	7	15%	142	30%
Innovation	2	5%	40	8%
Process and Production	12	26%	87	18%
Contextual Analysis and Evaluation (Self-Reflection)	7	15%	80	16%
Technical Writing	2	4%	16	3%
Totals	46	100%	474	100%

Table 11: Number of learning outcomes used within each iteration of mapping, comparing the first iteration subject-specific mapping to the many-to-one transferable mapping.

Further to this adjusting for hours worked in each skill area does not change the overall conclusions drawn from the graph, as all the figures are close or precisely the same as when only the number of learning outcomes in each category was taken into account;

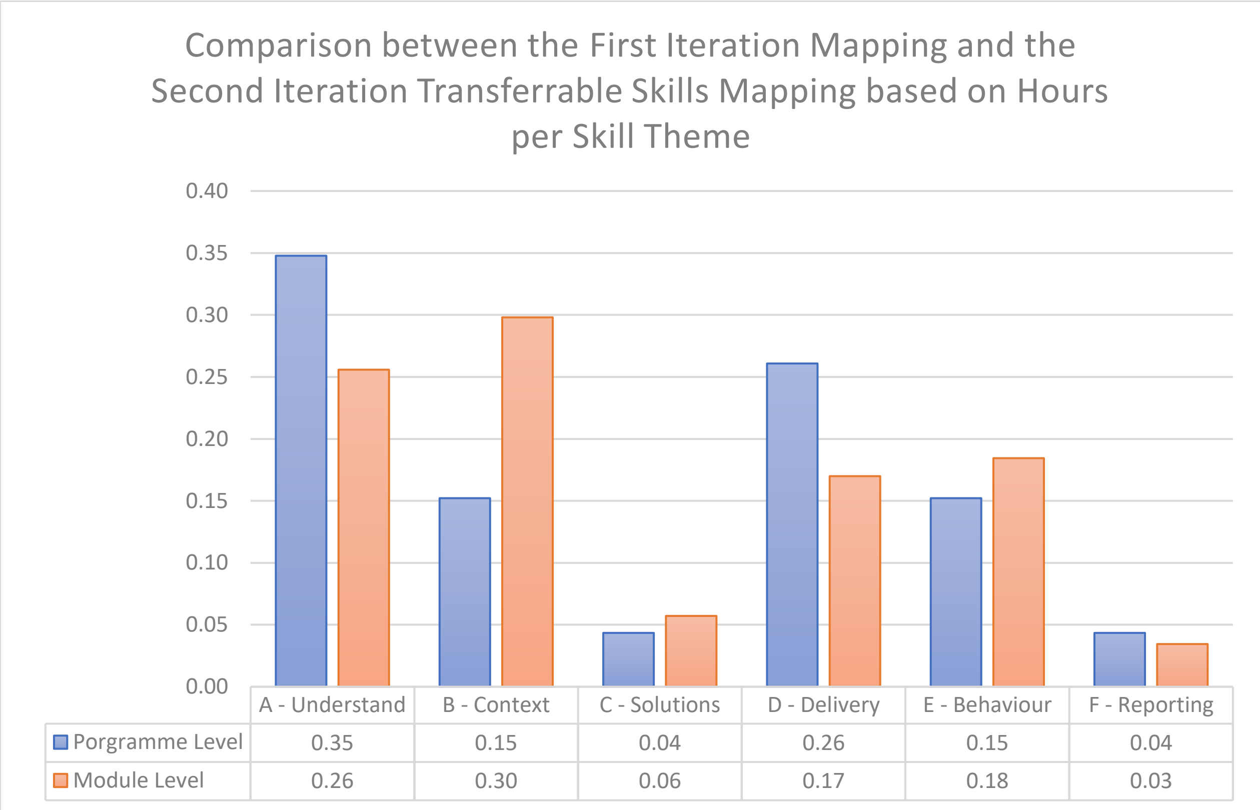

Figure 25: Percentage distribution of learning outcomes between the subject-specific mapping and transferrable skills from their respective mapping iterations based on the number of hours in each skill area.

This shows that both mapping solutions provide useable information about the distribution of skills and produce vital information which can be used to produce further and more in-depth insight into the skill distribution for a particular course of study. There is expected to be inaccuracies within this work, as the mapping solution between learning requirements to skill area is not exact and there is much overlap or need for interpretation to allow the mapping to take place.

4.4 Summary

In chapter 4, the application of the methodology has been explored. This has shown that the methodology described in chapter 3 produces viable results which can be used to describe the generic requirements of a particular discipline and the skills that professional bodies expect. This has shown that QAA and professional body list of requirements, at this point, are not exact due to how each professional body provides and describes their learning requirements.

Taking this further into a second iteration mapping based upon a specific programme of study, it shows that there can be significant variation in the number of learning requirements per year of a given programme. By taking each year to be 120 credits and each credit to be 10 hours of work, it was possible to produce a fairer depiction of expected skills on a particular programme of study and to provide great insight into the programme of study, this can allow for further analysis.

Finally, a comparison between the first and second iteration mapping was explored to see if each mapping solution produces results that could be classed as similar and be used as an additional check for accuracy. The check confirming that if information taken from different sources and at different levels of granularity can produce results that can provide the same level of insights to strengthen the trust of the methodology further, and in this case, it was seen to be comparable in most aspects.

Chapter 6

Conclusions and Recommendations

This research project explored higher education over the last few decades and saw how it has come under extraordinary pressures to adapt in a sustained period of rapid change; this is affecting graduates in an ever-challenging employment market. Due to such rapid change, this project explores the potential of using micro-credentialing as a transparent method of displaying the estimated number of hours expected for skills gained within a particular programme of study. The programme of the study investigated produces the following distribution of expected hours over the course of the degree;

	First Iteration	*Percentage*	*Second Iteration*	*Percentage*
Theoretical Knowledge	1260	35%	828	23%
Business Requirements and Applications	540	15%	1080	30%
Innovation	180	5%	288	8%
Process and Production	936	26%	648	18%
Contextual Analysis and Evaluation (Self-Reflection)	540	15%	576	16%
Technical Writing	144	4%	108	3%
Totals	3600	100%	3600	100%

Table 12: Table displaying the hours expected within each skill area over the course of the programme of study for both iterations of mapping.

This way of representing an individual's skills in a small and easy to understand list of skill areas with the amount of time placed within them could provide invaluable for every stakeholder. As a method, this would remove the uncertainty of skills within higher education degrees and the differing degrees on offer from other institutions with the aim of improving trust in the education system with it being more transparent and with the potential of such as the system being uniform across the world irrespective of their traditional higher educational systems.

With research like this, due to its exploratory nature, there is a lot of potential to have highly inaccurate results, therefore this project hinged upon using a two-tiered iterative method to self-moderate. The inaccuracies are mostly through the mapping process between learning requirements to skill areas, learning requirements were not produced based upon a codification of skill they are there to ensure are taught or assessed, while further inaccuracies can be presented through the one-to-one mapping of the professional body's requirements. The first iteration was based firmly within the current literature of the government and professional bodies and the 21st-Century Skills Framework. This allowed for a stable mapping based within the literature which could be used within comparisons with later more experimental mappings. The second mapping consisted of using module specification for a particular programme of study alongside split mapping progress for subject-specific skills and generally transferable skills to produce a more granular approach to micro-credentialing within a course of study.

Both mapping processes provided positive results for analysis and comparison displaying that both mapping processes provide useable information which can be used by module leaders to adjust their courses to hit specific areas if they find them to be lacking, this can only be a good thing for students as it would help provide a more comprehensive education with their field of choice. The first iteration mapping showed the vast difference between the approaches taken between the different committees within the QAA and their respective professional bodies. They were showing that even within the QAA benchmarks, there is little uniformity for transferable skill gained within subjects. The lack of uniformity is not a significant point of concern as these requirements are the minimum requirements for a degree programme within that subject. The lack of uniformity is only exacerbated within the professional body requirements with some having a high level of detail for their requirements, while others had very little in the way of standardised requirements. This presents an issue if a student decides to move programme there would be a lack of uniformity in this transition, this is something this thesis could not cover. A little amount of focus upon transferable skills is to be expected within professional accreditation as they focus on a particular subject matter only. Given that very few of these requirements had their focus upon transferable skills, this could make changing professions even more difficult and this is a limitation of the current mapping process and can potentially be refined in future iterations of it.

Second iteration mapping focused upon two different mappings with different amounts of detail between them. Different subjects could not be compared based upon subject-specific knowledge; it cannot be expected that Languages and Engineering subject-specific knowledge could be comparable due to the vast difference in skill areas trained. The same is not valid for transferable skills, because as is given in the name, they are transferable between subject matters. Therefore, much more focus has been placed upon transferable skills as it allows for much better comparisons. As discussed in the literature review, many businesses are looking for employees with balanced transferable skills to be able to work within many different roles within their business.

The results from both mapping iterations provided results for a reliable comparison between them which useful information can be obtained. It showed that the two different mapping approaches, even though relying upon the different starting material, provide comparable results showing that a module-based micro-credentialing mapping solution could be beneficial in a multitude of ways. A few could be the following;

- Providing more transparent information upon expected transferable skills gained within a particular programme of study. This could potentially help improve the standardisation of higher education league tables (Dill & Soo, 2005) while allowing potential students to make a more informed decision on which institution may be more suitable for them.
- Assisting employers when hiring new graduates, as a micro-credentialing system like this could allow for a more considered distinction between students who hold the game degree. The potential of reducing the amount of effort needed by the employer and potentially the graduate to complete interview assessments to test for the skills that are currently not reported on a transcript.
- Providing institutions with greater insight on their different programmes of study and allowing them to compare competing institutions, with the main aim of expediting the improvement of courses to cover a more varied set of transferable skills.

There could be potentially many more uses and implementation of micro-credentialing and use of a mapping solution to uncover the skills developed within a particular profession or educational programme. As this is an elementary view into the possibility of using micro-credentialing within a traditional programme of study, it does not cover any of the other uses or areas it could be extended into. There is a multitude of areas for future research such as an improved mapping solution, better codification of learning requirements or standardisation of learning requirements across subject areas, but this has not been explored within this research project. Further research in the following areas providing further revision for this framework could include;

- Research into the complexity of work produced within the different years of study, and how this could affect the development of different skill areas.
- Research into the differences within the different assessment methods and how this could potentially change how a particular student develops skills.
- Research into the presentation of learning outcomes at a module level and how the production of uniformity could allow for more comparable results between institutions.

While this is an elementary look into how micro-credentialing can be applied within a traditional programme of study, it does show considerable promise for further work and research to help change higher education for the better.

Appendices

Appendix A

Outlines the 21st-century skill framework and each of the six different skill themes used within the methodology.

Career and life	Learning and innovation	Information literacy	core subjects and 21st-century skills	Subject Specific
Initiative and self-direction	Creativity and innovation	Information Literacy	Financial, economic, business, and entrepreneurial	Theoretical knowledge
Leadership and responsibility	Critical thinking and problem solving	ICT literacy	Civil literacy	Process and production
Flexibility and adaptability	Communication and collaboration	Media literacy	Environmental literacy	Business requirements and applications
Social and cross-cultural skills			Global Awareness	Contextual analysis and evaluation (self-reflection)
Productivity and accountability			Health Literacy	Technical writing
				Innovation

Table 13: Table displaying how each different skill is assigned to a category.

Appendix B

List of learning outcomes gathered from the QAA benchmark for computing used to help depict how the mapping takes place.

Learning outcomes
Self-management: self-awareness and reflection; goal setting and action planning; independence and adaptability; acting on initiative; innovation and creativity. The ability to work unsupervised, plan effectively and meet deadlines, and respond readily to changing situations and priorities.
Knowledge and understanding of the management techniques which may be used to achieve objectives within a computing context.
Interaction: reflection and communication; the ability to succinctly present rational and reasoned arguments that address a given problem or opportunity, to a range of audiences (orally, electronically or in writing).
An ability to work as a member of a development team recognising the different roles within a team and different ways of organising teams.
Intellectual skills: critical thinking; making a case; numeracy and literacy; information literacy. The ability to construct well-argued and grammatically correct documents. The ability to locate and retrieve relevant ideas and ensure these are correctly and accurately referenced and attributed.
An understanding of the scientific method and its applications to problem-solving in this area.
Computational thinking, including its relevance to everyday life.
The ability to recognise the legal, social, ethical, and professional issues involved in the exploitation of computer technology and be guided by the adoption of appropriate professional, ethical and legal practices.

Sustainability: recognising factors in environmental and societal contexts relating to the opportunities and challenges created by computing systems across a range of human activities.
An understanding of the scientific method and its applications to problem-solving in this area
Knowledge and understanding of essential facts, concepts, principles, and theories relating to computing and computer applications as appropriate to the programme of study.
The ability to deploy appropriate theory, practices and tools for the specification, design, implementation, and evaluation of computer-based systems.
Requirements, practical constraints, and computer-based systems (this includes computer systems, information, security, embedded, and distributed systems) in their context: recognise and analyse criteria and specifications appropriate to specific problems, and plan strategies for their solutions.
Methods and tools: deploy appropriate theory, practices and tools for the specification, design, implementation, and evaluation of computer-based systems.
The ability to critically evaluate and analyse complex problems, including those with incomplete information, and devise appropriate solutions, within the constraints of a budget.
The use of such knowledge and understanding in the modelling and design of computer-based systems for the purposes of comprehension, communication, prediction, and the understanding of trade-offs.
Critical evaluation and testing: analyse the extent to which a computer-based system meets the criteria defined for its current use and future development.
The ability to evaluate systems in terms of general quality attributes and possible trade-offs presented within the given problem.
The ability to deploy effectively the tools used for the construction and documentation of computer applications, with particular emphasis on understanding the whole process involved in the effective deployment of computers to solve practical problems.

Table 14: Table displaying all the learning requirements from the QAA benchmarks for Computing.

The next few figures are the final mappings for the QAA Benchmarks for each of the disciplines considered within the first iteration mapping;

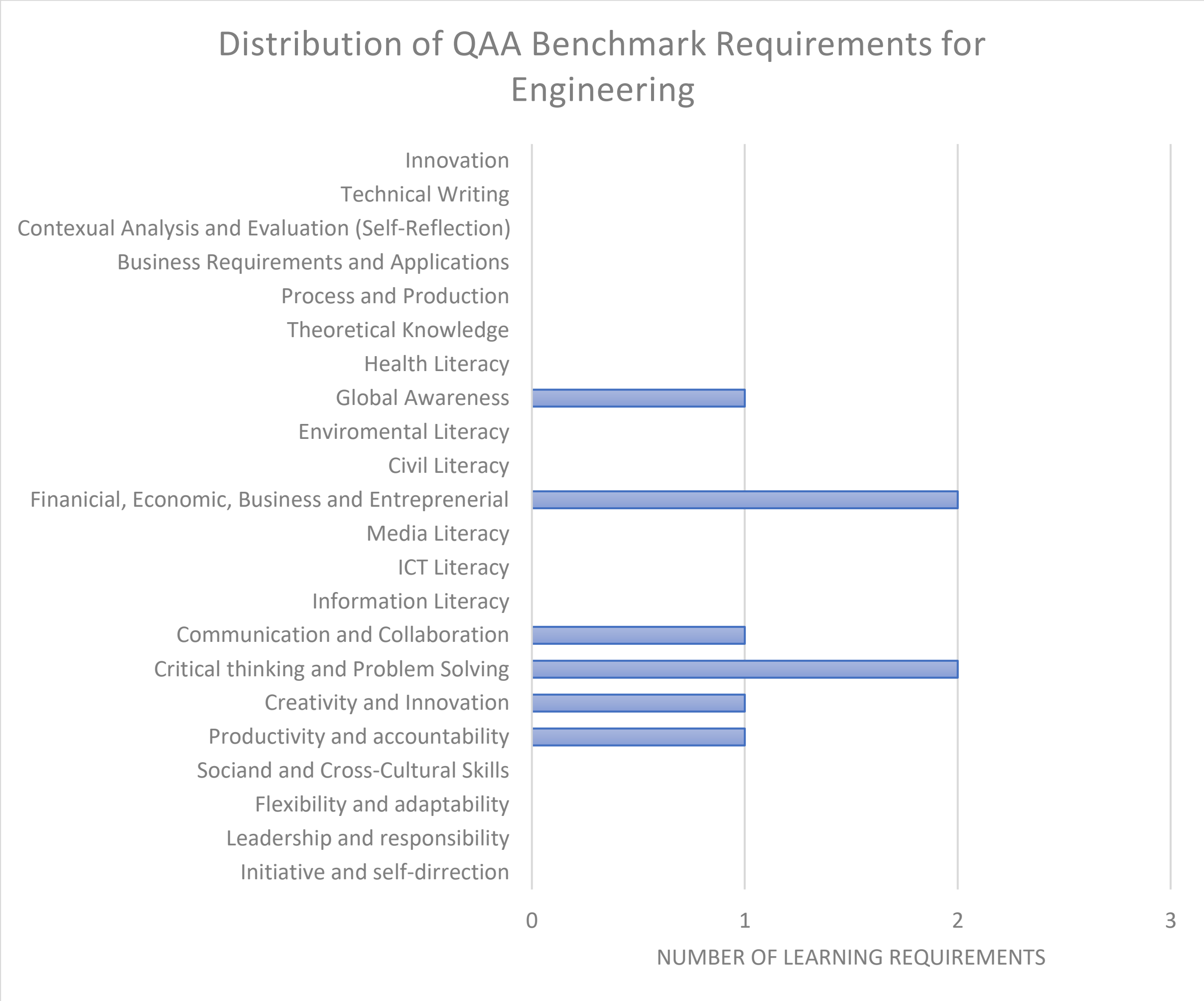

Figure 26: Figure displaying the distribution of the QAA benchmark learning requirements to each skill area for Engineering.

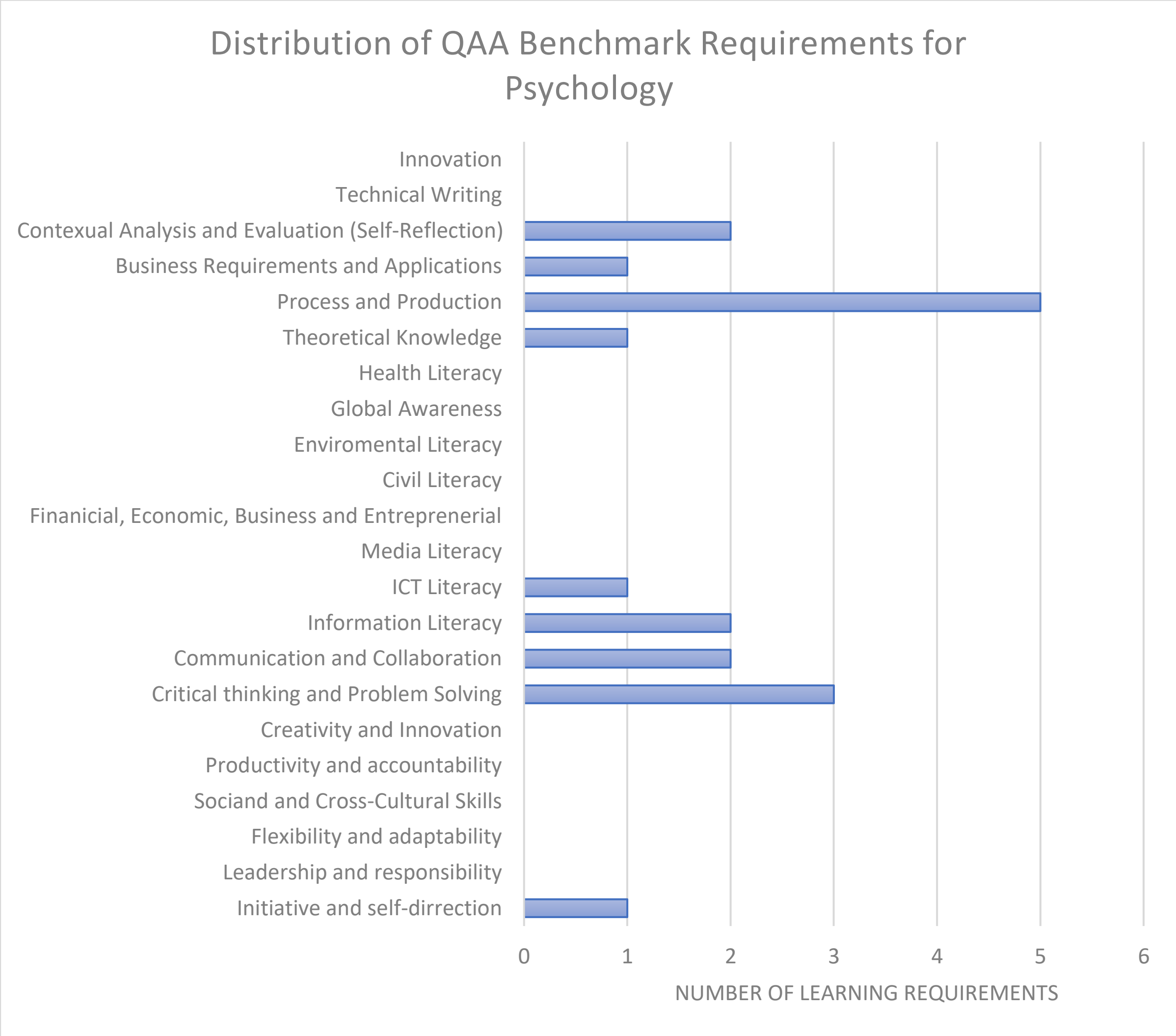

Figure 27: Figure displaying the distribution of the QAA benchmark learning requirements to each skill area for Psychology.

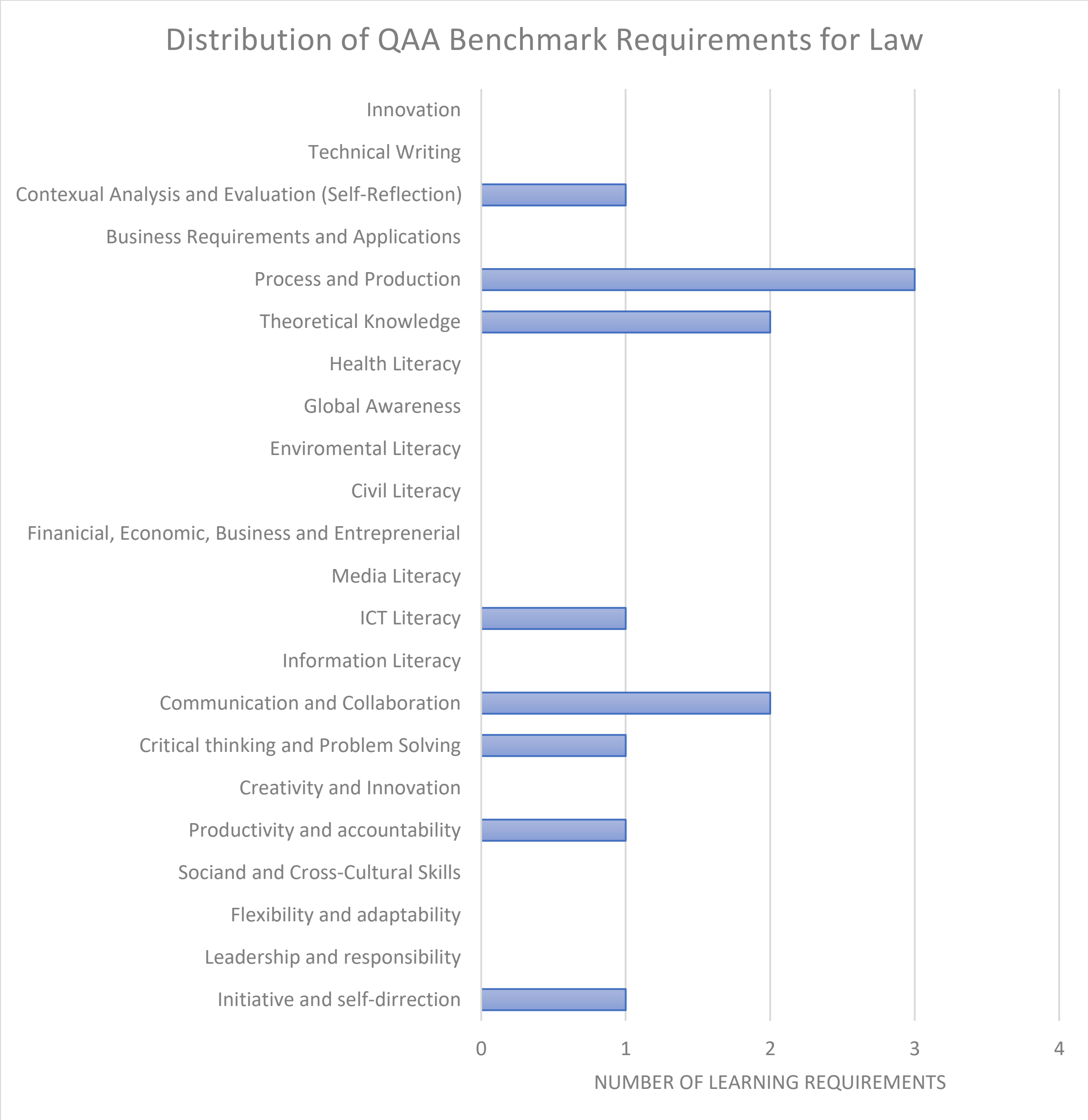

Figure 28: Figure displaying the distribution of the QAA benchmark learning requirements to each skill area for law.

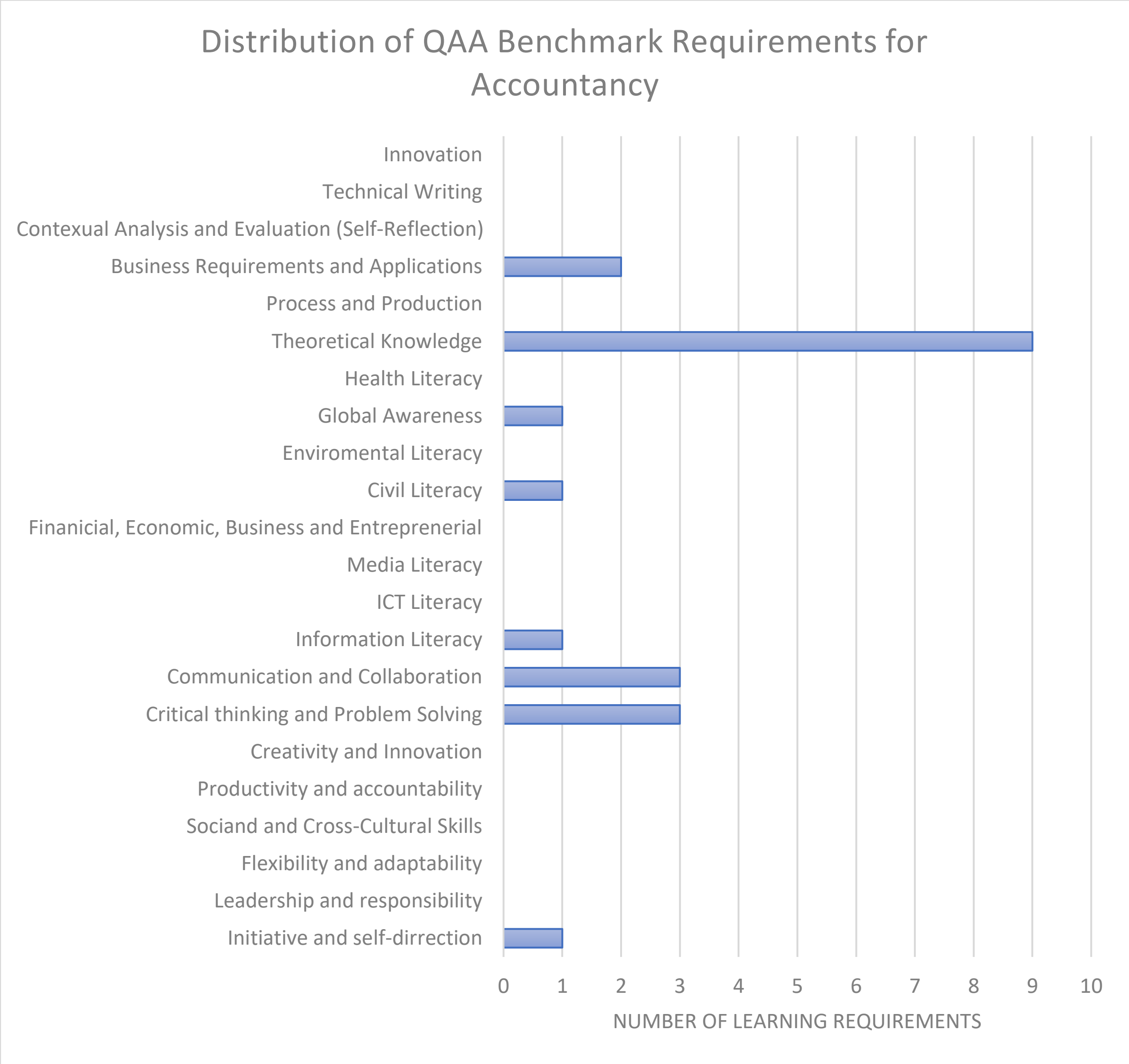

Figure 29: Figure displaying the distribution of the QAA benchmark learning requirements to each skill area for Accountancy.

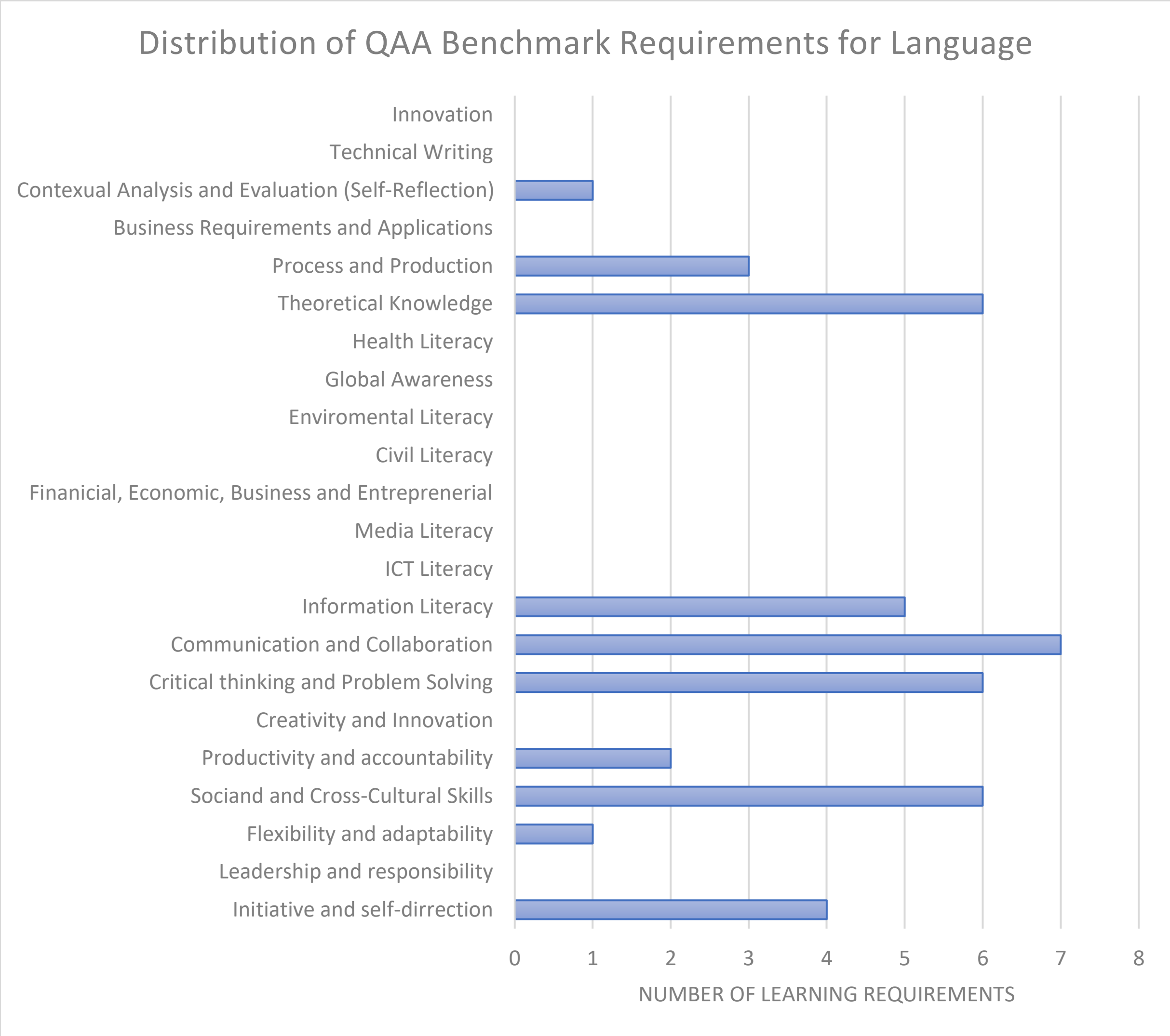

Figure 30: Figure displaying the distribution of the QAA benchmark learning requirements to each skill area for Language.

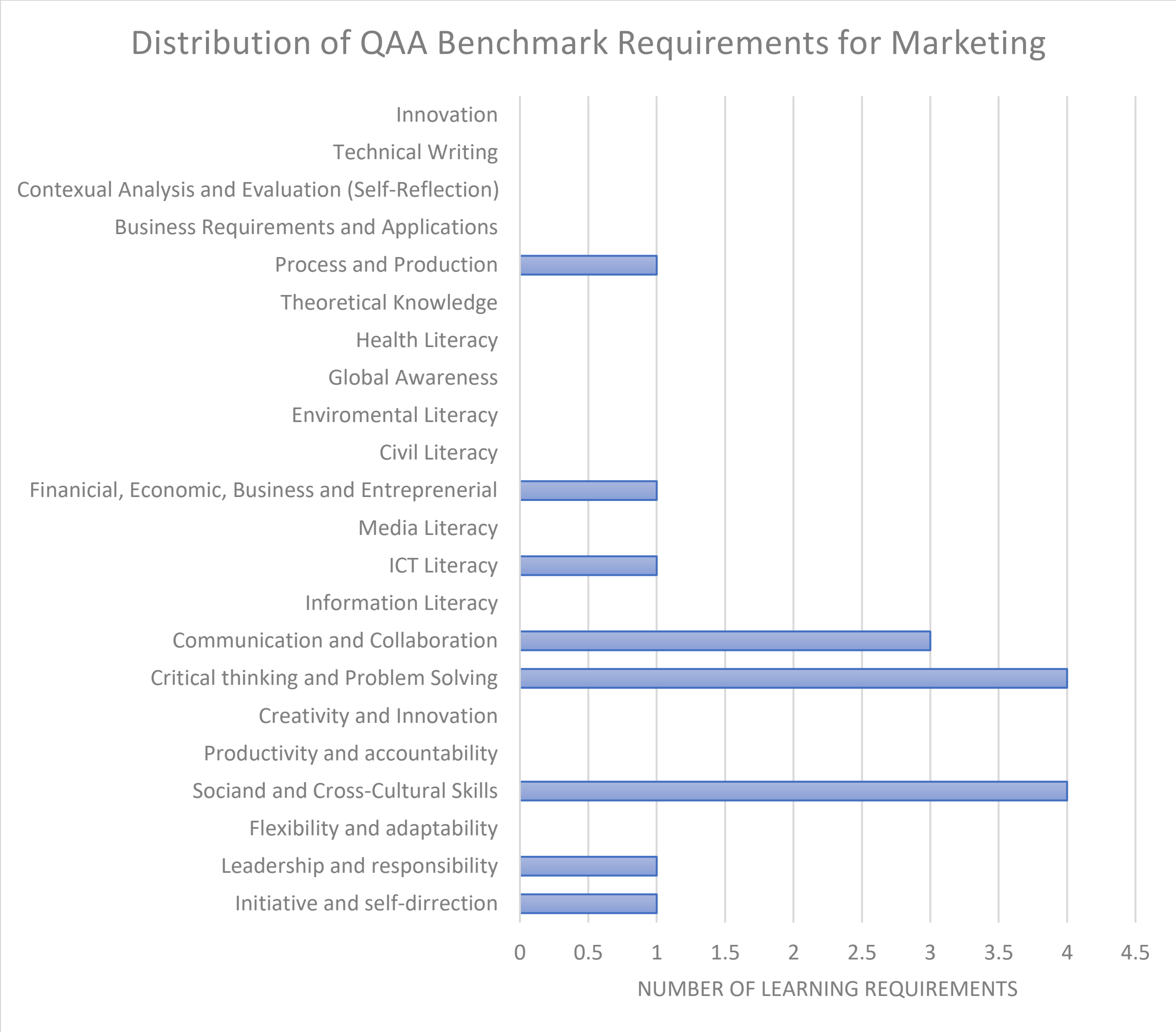

Figure 31: Figure displaying the distribution of the QAA benchmark learning requirements for each skill area for Marketing.

Appendix C

Figures depicting the different levels of accreditation for each of the disciplines considered in the first iteration mapping;

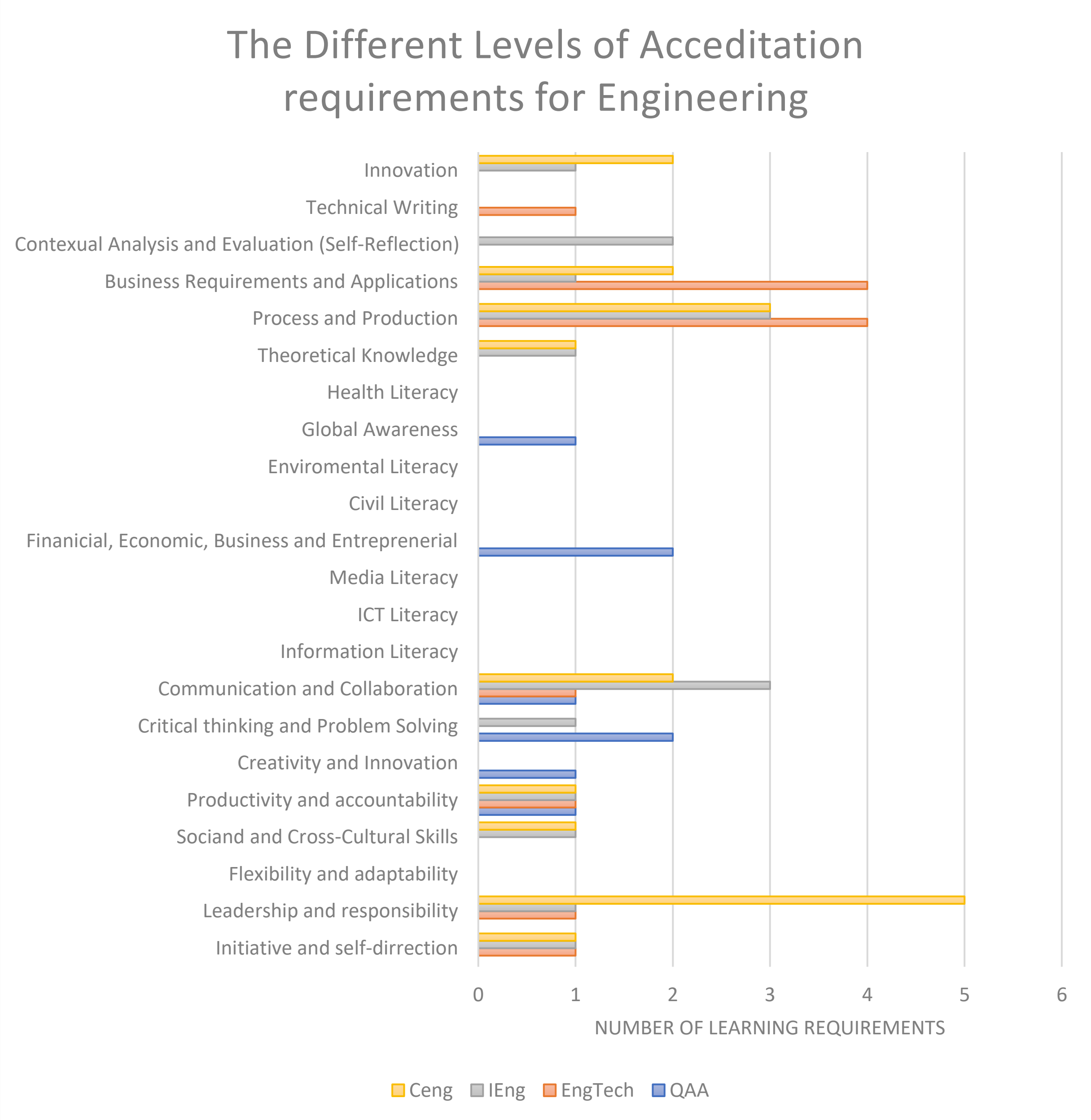

Figure 32: Graph displaying the number of learning requirements for each of the different accreditation levels for engineering.

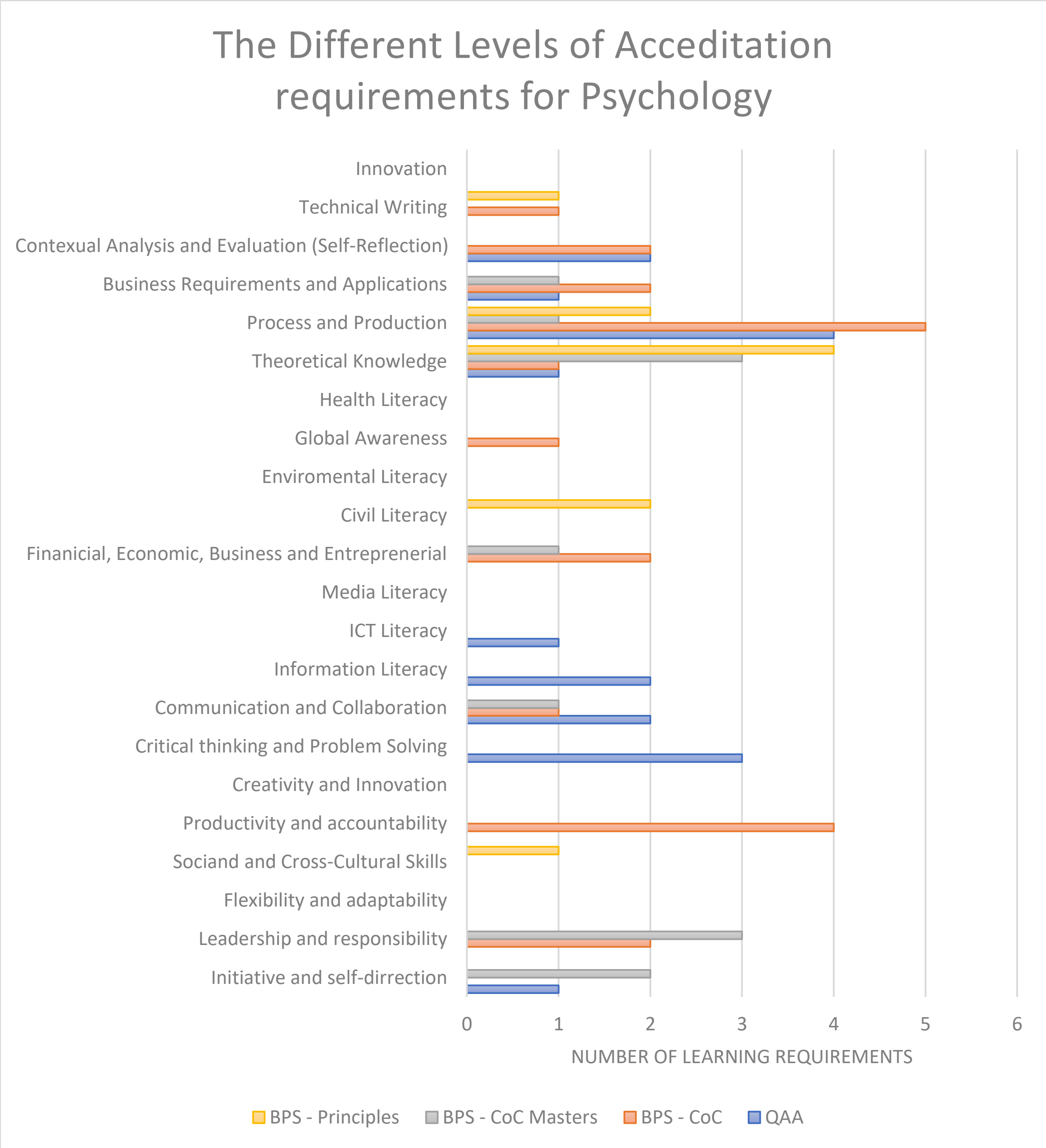

Figure 33: Graph displaying the number of learning requirements for each of the different accreditation levels for psychology.

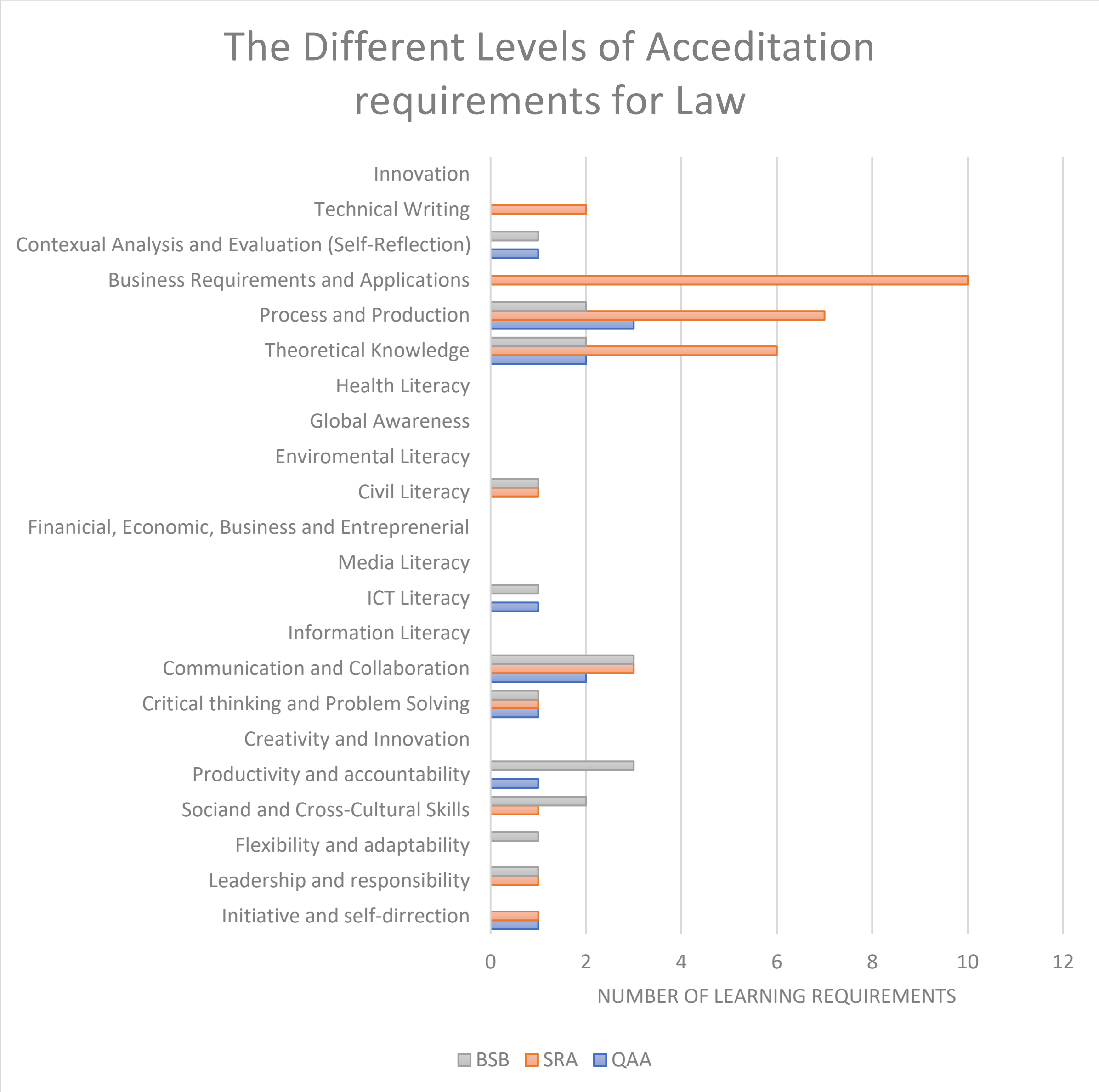

Figure 34: Graph displaying the number of learning requirements for each of the different accreditation levels for law.

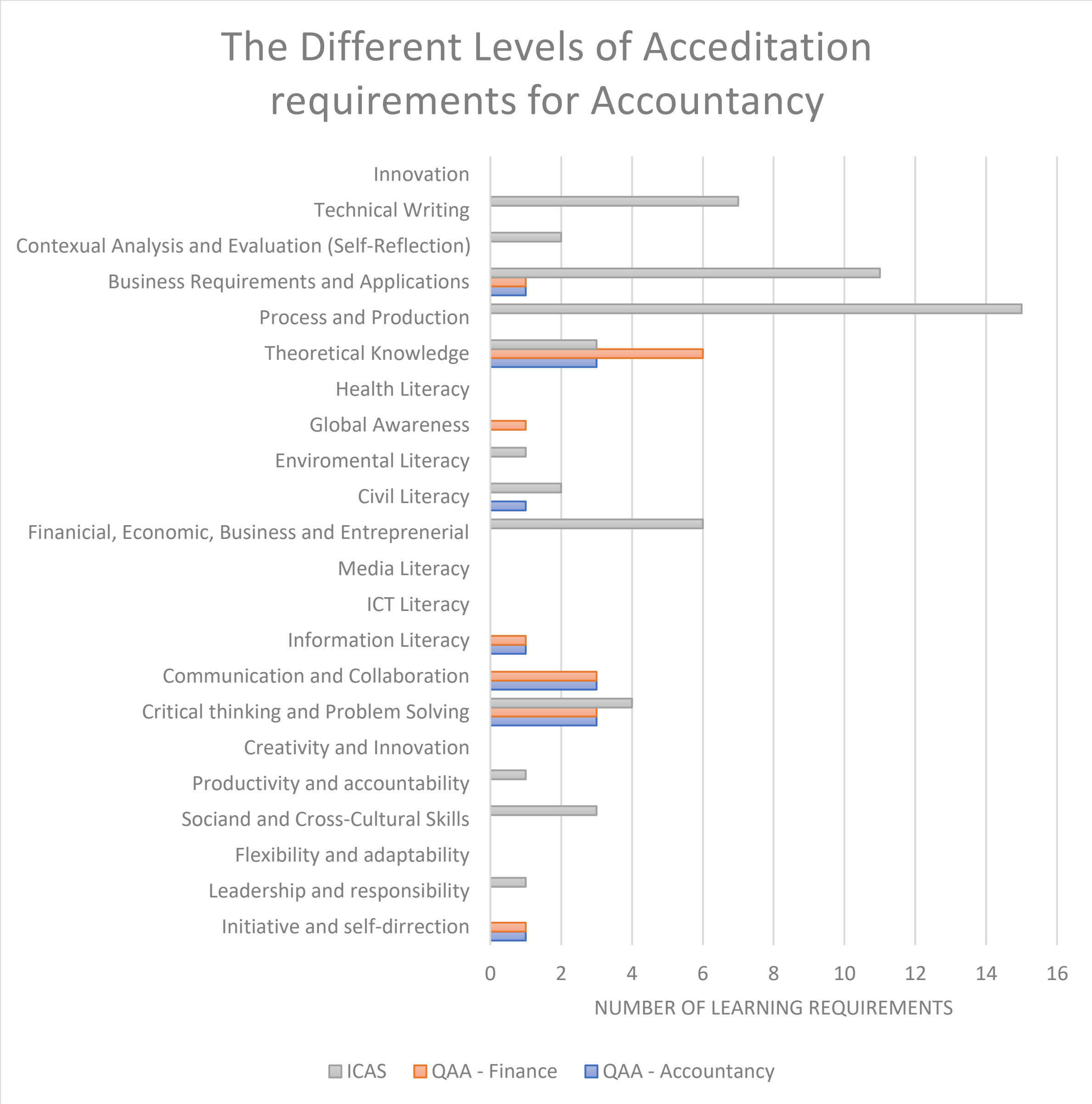

Figure 35: Graph displaying the number of learning requirements for each of the different accreditation levels for accountancy.

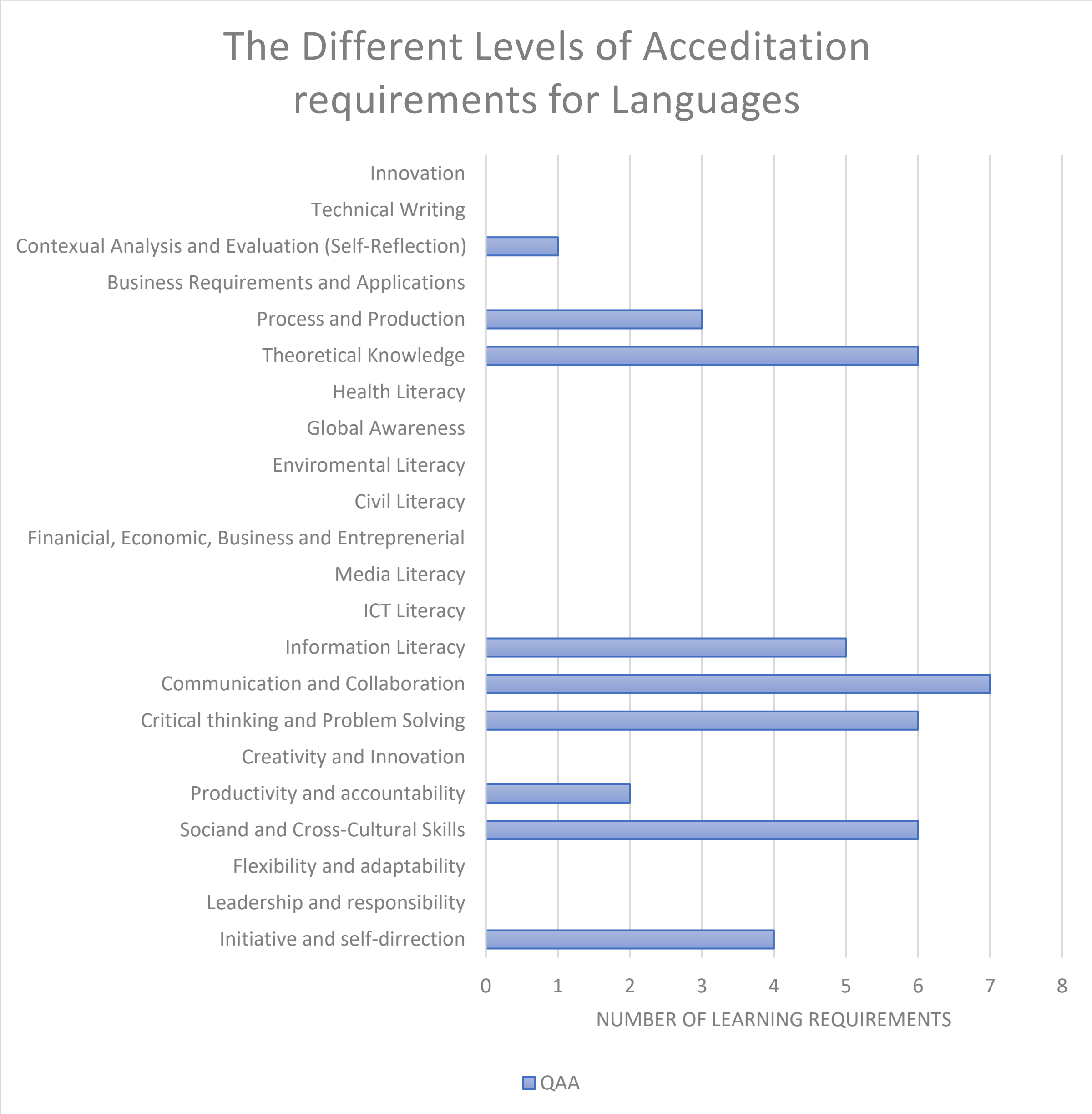

Figure 36: Graph displaying the number of learning requirements for each of the different accreditation levels for languages.

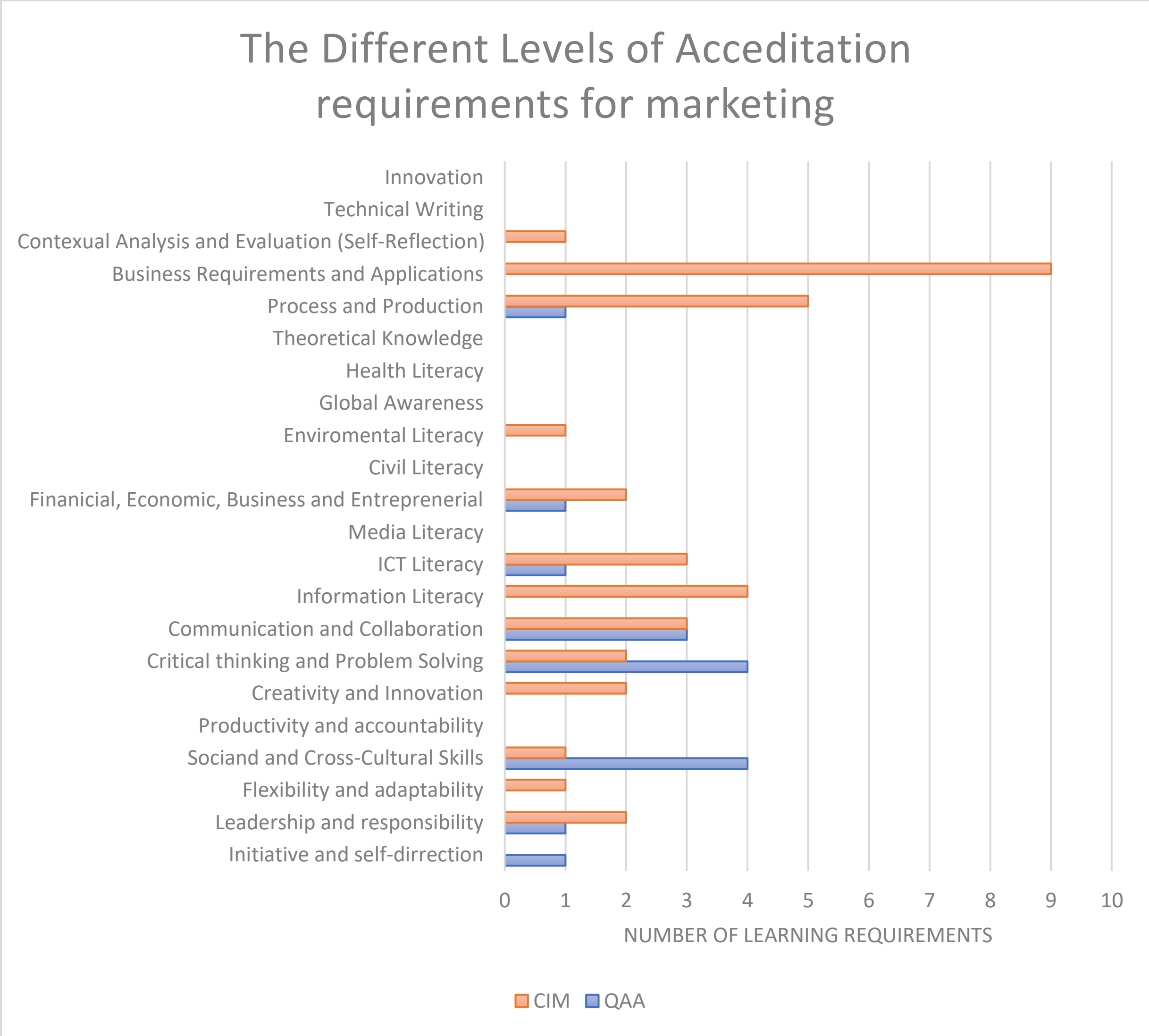

Figure 37: Graph displaying the number of learning requirements for each of the different accreditation levels for marketing.

Appendix D

These tables depict the number of learning outcomes per module used within the second iteration mapping in chapter 4.

	MODULE CODE	MODULE NAME	LEARNING OUTCOMES	1A	2B	3C	4D	5E	6F
YEAR ONE	CFS2160	Software Design and Development	8	-	-	-	5	2	1
	CFM2175	Computing Science and Mathematics	12	5	-	-	7	-	-
	CFS2143	Hardware and Networks	9	4	-	-	5	-	-
	CFT2112	Studio 1	6	2			2	2	
	CFP2125	Project 1	6	-	1	-	2	3	-
YEAR TWO	CIS2344	Algorithms, Processes and Data	8	3	-	-	4	-	1
	CII2350	Team Project	8	2	2	-	1	1	1
	CIS2360	Relational Databases and Web	10	-	1	-	7	2	-
	CIS2201	Cyber Security	10	3	-	-	5	2	-
	CIS2380	Operating Systems and Language Translators	8	4	-	-	3	-	1
	CIM2130	Computational Mathematics	10	2	-	-	8	-	-
YEAR THREE	CSP2010	Personal Social and Technical Skills	3	-	-	-	-	-	-
	CSP2020	Self-Assessment Skills	7	-	-	-	-	-	-
YEAR FOUR	CHP2524	Individual Project	7	2	-	1	2	1	1
	CHS2546	Distributed and Client-Server Systems	7	2	2		3	-	-
	CHA2555	Artificial Intelligence	8	5	-	-	2	1	-
	CHM2130	Computational Mathematics 2	7	3	-	-	4	-	-
	CHS2402	Large-Scale Software Engineering	5	1	1	-	-	2	1

Table 15: Table showing the distribution of learning outcomes for each module for the subject-specific skill containers.

	MODULE CODE	***MODULE NAME***	***HOURS PER MODULE***	***1A***	***2B***	***3C***	***4D***	***5E***	***6F***
Year One	CFS2160	Software Design and Development	400	-	-	-	226.67	106.67	66.67
	CFM2175	Computing Science and Mathematics	200	83.33	-	-	116.67	-	-
	CFS2143	Hardware and Networks	200	80	-	-	120	-	-
	CFT2112	Studio 1	200	66.67	-	-	66.67	66.67	-
	CFP2125	Project 1	200	-	30	-	63.33	106.67	-
Year Two	CIS2344	Algorithms, Processes and Data	200	75	-	-	100	-	25
	CII2350	Team Project	200	48	56	-	20	28	28
	CIS2360	Relational Databases and Web	200	-	25	-	141.67	33.33	-
	CIS2201	Cyber Security	200	60	-	-	100	40	-
	CIS2380	Operating Systems and Language Translators	200	93.33	-	-	73.33	33.33	-
	CIM2130	Computational Mathematics	200	33.33	-	-	166.67	-	-
Year Three	CSP2010	Personal Social and Technical Skills	200	-	-	-	-	-	-
	CSP2020	Self-Assessment Skills	200	-	-	-	-	-	-
Year Four	CHP2524	Individual Project	400	137.14	-	28.57	57.14	68.57	68.57
	CHS2546	Distributed and Client Server Systems	200	48.57	68.57	-	82.86	-	-
	CHA2555	Artificial Intelligence	200	126.67	-	-	36.67	36.67	
	CHM2130	Computational Mathematics 2	200	100	-	-	100	-	-
	CHS2402	Large-Scale Software Engineering	200	33.33	58.33	-	-	50	58.33

Table 16: Table showing the distribution of learning outcomes for each module for subject-specific skill containers when taking into consideration module credits, assessment weighting and varying learning outcomes.

The tables on the following pages detail the number of learning requirements and then the number of hours in each of the transferrable skill containers for each module, used within chapter 4.

	Module Code	*Module Name*	*Learning Outcomes*	*7A*	*8B*	*9B*	*10B*	*11B*	*12C*	*13C*	*14D*	*15D*	*16D*	*17D*	*18E*	*19E*	*20E*	*21E*	*22E*	*23E*	*24E*	*25F*
Year One	CFS2160	Software Design and Development	8	8	3	0	4	7	0	6	8	0	0	0	0	0	4	0	0	0	0	1
	CFM2175	Computing Science and Mathematics	12	9	0	0	10	6	0	2	3	0	0	0	0	0	0	0	0	0	0	0
	CFS2143	Hardware and Networks	9	9	0	0	1	4	0	3	6	0	0	0	0	0	0	0	0	0	0	0
	CFT2112	Studio 1	6	4	3	0	0	4	0	2	2	0	0	0	0	1	2	2	1	0	0	1
	CFP2125	Project 1	6	3	4	0	0	2	1	3	0	1	0	1	0	0	5	0	0	1	2	2
Year Two	CIS2344	Algorithms, Processes and Data	8	5	3	0	4	4	0	2	3	0	0	0	0	0	2	0	0	0	0	0
	CII2350	Team Project	8	3	5	0	0	0	1	2	3	3	2	3	2	1	2	1	1	1	4	5
	CIS2360	Relational Databases and Web	10	10	7	0	0	3	0	0	9	0	0	0	0	0	5	0	0	0	0	1
	CIS2201	Cyber Security	10	8	5	0	1	6	0	1	4	0	0	0	0	2	4	2	0	0	0	0
	CIS2380	Operating Systems and Language Translators	8	8	0	0	0	2	0	0	8	0	0	0	0	0	0	0	0	0	0	0
	CIM2130	Computational Mathematics	10	10	0	0	10	8	0	5	0	0	0	0	0	0	0	0	0	0	0	0
Year Three	CSP2010	Personal Social and Technical Skills	3	1	3	0	0	0	0	2	2	3	3	0	3	3	0	0	0	3	3	3
	CSP2020	Self-Assessment Skills	7	0	6	0	0	0	0	0	0	3	0	0	6	0	4	0	0	0	0	0
Year Four	CHP2524	Individual Project	7	5	4	0	0	3	0	1	6	0	0	0	0	1	4	2	0	0	0	1
	CHS2546	Distributed and Client Server Systems	7	7	3	0	0	1	0	2	4	0	0	0	0	0	1	0	0	0	0	0
	CHA2555	Artificial Intelligence	8	8	1	0	0	0	0	3	6	0	0	0	0	0	0	0	0	0	0	0
	CHM2130	Computational Mathematics 2	7	7	1	0	7	4	0	4	2	0	0	0	0	0	0	0	0	0	0	0
	CHS2402	Large-Scale Software Engineering	5	4	1	0	0	2	0	0	2	0	0	0	0	1	2	2	0	0	0	2

Table 17:Displaying the one-to-many mapping of learning outcomes to the transferrable skill containers, using references explained in Table 7.

	Module Code	*Module Name*	*Learning Outcomes*	*7A*	*8B*	*9B*	*10B*	*11B*	*12C*	*13C*	*14D*	*15D*	*16D*	*17D*	*18E*	*19E*	*20E*	*21E*	*22E*	*23E*	*24E*	*25F*
Year One	CFS2160	Software Design and Development	8	80	30	0	38	67	0	54	80	0	0	0	0	0	39	0	0	0	0	13
	CFM2175	Computing Science and Mathematics	12	76	0	0	73	32	0	7	12	0	0	0	0	0	0	0	0	0	0	0
	CFS2143	Hardware and Networks	9	112	0	0	4	22	0	16	46	0	0	0	0	0	0	0	0	0	0	0
	CFT2112	Studio 1	6	61	34	0	0	31	0	15	19	0	0	0	0	5	13	11	5	0	0	5
	CFP2125	Project 1	6	27	45	0	0	17	4	21	0	8	0	4	0	0	41	0	0	8	12	12
Year Two	CIS2344	Algorithms, Processes and Data	8	105	18	0	23	23	0	9	14	0	0	0	0	0	9	0	0	0	0	0
	CII2350	Team Project	8	20	37	0	0	0	2	5	12	13	6	9	6	9	21	9	9	2	16	23
	CIS2360	Relational Databases and Web	10	62	39	0	0	14	0	0	56	0	0	0	0	0	22	0	0	0	0	6
	CIS2201	Cyber Security	10	63	28	0	10	28	0	5	18	0	0	0	0	15	18	15	0	0	0	0
	CIS2380	Operating Systems and Language Translators	8	93	0	0	0	13	0	0	93	0	0	0	0	0	0	0	0	0	0	0
	CIM2130	Computational Mathematics	10	63	0	0	63	46	0	28	0	0	0	0	0	0	0	0	0	0	0	0
Year Three	CSP2010	Personal Social and Technical Skills	3	18	63	0	0	0	0	38	38	63	63	0	63	63	0	0	0	63	63	63
	CSP2020	Self-Assessment Skills	7	0	363	0	0	0	0	0	0	38	0	0	138	0	63	0	0	0	0	0
Year Four	CHP2524	Individual Project	7	87	73	0	0	23	0	7	97	0	0	0	0	5	49	16	0	0	0	23
	CHS2546	Distributed and Client Server Systems	7	101	30	0	0	9	0	15	38	0	0	0	0	0	7	0	0	0	0	0
	CHA2555	Artificial Intelligence	8	113	6	0	0	0	0	24	57	0	0	0	0	0	0	0	0	0	0	0
	CHM2130	Computational Mathematics 2	7	70	6	0	70	23	0	23	8	0	0	0	0	0	0	0	0	0	0	0
	CHS2402	Large-Scale Software Engineering	5	69	7	0	0	19	0	0	19	0	0	0	0	7	19	41	0	0	0	19

Figure 18: Displaying the one-to-many mapping of learning outcomes to the transferrable skill containers, using references explained in Table 6. These values are all nearest the hour after all factors have been taken into consideration.

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